

1.1 Terms of reference

The Review of Policy on Non-Native Species was commissioned by Ministers in response to the growing concern that current arrangements were not sufficient and that further action was needed. The terms of reference of the policy review are set out below.

The problems caused by non-native species can be serious by transforming our ecosystems, damaging crops, altering natural habitats and threatening native species. This issue needs to be addressed in a co-ordinated way, involving Government, Industry and Conservation bodies who need to consider the causes of, and problems arising from, the introduction and spread of non-native species. For this reason the Government announced, during the passage of the Countryside and Rights of Way Act, that it would undertake a review of its policies concerning non-native species early in 2001.

This undertaking was reinforced in the Government's Rural White Paper *"Our Countryside: The Future – A Fair Deal For Rural England"* which identified the need to carry out a fundamental review of the policy on alien and invasive species.

Objectives:

The review process will:

- evaluate the effectiveness of current statutory or non-statutory procedures for dealing with the introduction and establishment of non-native species and identify examples of current best practice within the United Kingdom and abroad;
- identify the main vectors for the introduction and spread of non-native species;
- put forward practical and proportionate costed proposals for improving measures to limit the ecological and economic impact of non-native species in Great Britain and recommend measures to limit the impact of the introduction of native species beyond their natural range. These could include proposals for statutory or non-statutory measures in areas of research and monitoring, trade, and control of non-native species; and
- identify appropriate organisations to take forward any measures recommended.

Scope of the review:

The review will:

- be carried out on a Great Britain basis for terrestrial, freshwater and marine environments;
- cover all species of fauna and flora except agricultural crops and genetically modified organisms;
- take account of the appropriate International and European Agreements relating to the introduction of non-native species; and
- involve all appropriate stakeholders.

Many of the relevant functions are devolved and the Review therefore needed to be agreed by Ministers in the devolved administrations. Likewise the report will be submitted to Ministers in the Department for Environment, Food and Rural Affairs (Defra) and in the devolved administrations. The Review was carried out on a Great Britain rather than UK basis, as this was considered preferable in biogeographic terms. In Northern Ireland, consideration is being given to addressing the issue of non-native species on an all-Ireland basis, as recommended by the Northern Ireland Biodiversity Group.

It should be noted that the remit of the review does not extend to micro-organisms and other pathogens that cause disease in farmed animals and birds. There is a large body of separate legislation to cover these issues.

The list of recommendations is set out here in order of the Key recommendations, with the supporting Sub-recommendations listed underneath each Key recommendation. Several miscellaneous recommendations are listed at the end.

- **Key Recommendation 1: The Government should designate or create a single lead co-ordinating organisation to undertake the role of co-ordinating and ensuring consistency of application of non-native species policies across Government.**
- **Key Recommendation 2: Develop comprehensive risk assessment procedures to assess the risks posed by non-native species and identifying and prioritising areas for other prevention action.**

Sub-recommendation 2.1:

Although it is clear that, for many taxa, there are no easy short cuts to risk assessments, further analysis of the attributes of species successfully invading Great Britain should be undertaken.

Sub-recommendation 2.2:

Plant health risk assessment standards and schemes should be used as a basis for constructing a general risk assessment scheme that can be applied to all non-native species. Plant health risk assessment procedures are widely applied and already recognised by the World Trade Organisation. Their use as a basis for generic risk assessments is likely to increase the speed with which they are accepted and adopted.

Sub-recommendation 2.3:

High priority should be given to developing and publishing a risk assessment scheme suitable for all non-native species. To foster best practice this would ideally be presented in the form of a manual supported by guidance, examples of best practice and a tool kit identifying, for example, suitable reference material.

Sub-recommendation 2.4:

In the light of consultation with interested parties outlined in the two sub-recommendations (2.5 & 2.6) below, a list of problem species should be developed for priority action including licensing and even exclusion from Britain (a 'High Risk List'), a list of species where more evidence is required as to their potential to cause problems (an 'Medium Risk List') and possibly also a list of species assessed as not being known to cause problems (a 'Low Risk List')

Sub-recommendation 2.5:

Further consultation is needed with the horticultural industry and other interested parties to determine the extent to which it would be practicable to require risk assessments on all new imported and introduced plant taxa.

Sub-recommendation 2.6:

Further consultation is needed with the horticultural industry and other interested parties to determine whether the creation of lists of non-native species known and demonstrated to have no negative effects ('low risk' or 'harmless' lists) would be achievable and beneficial.

Sub-recommendation 2.7:

Comparative assessments should be undertaken of the risks of introducing non-native species to Great Britain by a variety of importation pathways, as a basis for prioritising resources to the detection, monitoring and management of non-native species entering Great Britain.

- **Key Recommendation 3: Develop codes of conduct to help prevent introductions for all relevant sectors in a participative fashion involving all relevant stakeholders.**
- **Key Recommendation 4: Develop a targeted education and awareness strategy involving all relevant sectors.**

Sub-recommendation 4.1:

Messages about invasive non-native species which are promoted to the public revolve around a small number of key concepts, and should use simple, understandable terminology, and plan in advance to deal with controversial aspects of the issues.

Sub-recommendation 4.2:

A general information campaign should be undertaken to inform the general public of the issues surrounding invasive non-native species, through easily accessible media such as television, radio and the press, and through media targeted to key areas, activities and locations, such as garden centres, pet shops, and airports.

Sub-recommendation 4.3:

Detailed discussions should commence with specialist societies and recording schemes, with the aim of enhancing the reporting systems which already exist for most taxa, to provide effective reporting of non-native species. Consideration should be given to the development of E-mail reporting, and the provision of web-based feedback on non-native species. Formal education courses should include information about non-native species issues where appropriate.

Sub-recommendation 4.4:

Carefully-targeted material should be produced to cater for the information and advisory needs of the range of professionals likely to have an impact on invasive non-native species issues. This will differ between sectors, and should include detailed professional and scientific analysis of the issues associated with invasive non-native species, material presented in terms appropriate to non-scientists and the public, as well as material appropriate to the scientific and research communities.

Sub-recommendation 4.5:

There is a need to raise awareness of the problems caused by introducing native species beyond their natural range so as to prevent their impacts in future.

Sub-recommendation 4.6:

The issue of use of non-native genotypes of native species is important and requires further consideration, building on existing initiatives such as those by the Forestry Commission and Flora Locale. There is a need to raise public awareness of this issue.

Sub-recommendation 4.7:

There should be a public campaign to “develop an awareness culture” concerning the problems that can be caused by invasive non-native species, and to increase appreciation of the cultural heritage and value of native biodiversity. This should be planned professionally, resourced appropriately, and it should be expected to be a long-term process and avoid an over-simplified message of native equals good, non-native equals bad.

- **Key Recommendation 5: Revise and update existing legislation to improve handling of invasive non-native species issues.**

Sub-recommendation 5.1:

Reform legislation to: ensure plants and animals are treated equally in law; ensure the correct list of species are targeted with legislative action, which should include a ban on the sale of relevant species; define duty of care by legal underpinning for codes of conduct and incorporate into EIA legislation for risk assessment for major developments that could lead to unintentional introductions of problem invasive species; provide for suitable powers and responsibilities for enforcement where required.

Sub-recommendation 5.2:

Consideration should be given to identifying those circumstances where responsibility for management or its costs should lie with those responsible for the illegal introduction of the non-native species. Consideration should also be given to providing a legal basis for imposing fines on the ‘polluter pays’ principle.

Sub-recommendation 5.3:

Careful consideration should be given to amendment of the wildlife legislation in respect of the introduction and establishment of species which are native to parts of Britain into areas beyond their natural range. This is of particular relevance in respect of the introduction of species onto islands within Great Britain.

Also supporting this key recommendation:

Sub-recommendation 5.4:

Consideration should be given to providing powers of compulsory access, compatible with The Human Rights Act 1998, to allow the control of non-native species by statutory bodies, with guidelines produced to ensure that these are used sparingly and as a last resort for effective control.

Sub-recommendation 5.5:

Existing legislation should be reviewed to identify areas where protection is inadvertently given to invasive non-native species by default, and that consideration should be given to inserting an exemption for non-native species, whilst providing animal welfare safeguards in relation to the methods by which they may be controlled.

- **Key Recommendation 6: Establish adequate monitoring and surveillance arrangements for non-native species in Great Britain.**

Sub-recommendation 6.1:

Work should be undertaken to classify the status of all macro-organisms in Great Britain. This is a key task to underpin work on non-native species. The Review Group notes that there is no clear view on the way in which criteria should be set, and recommends that further research is necessary to determine how these should be applied.

Sub-recommendation 6.2:

Measures to develop monitoring systems for non-native species should not be delayed while classification work is completed, since the need for monitoring will remain, even if the list of species and habitats which require monitoring may require further modification.

Sub-recommendation 6.3:

A group of experts should be formed to collate scientific information on those species which are considered to have the highest potential for arrival and establishment in Britain, and which may cause conflicts.

Sub-recommendation 6.4:

Britain should play a key role in supporting the development of international networks on invasive non-native species, in order to improve the flow of information about the impacts of invasive non-native species in climates similar to that in Britain.

Sub-recommendation 6.5:

Priority should be given to developing information exchange with Britain's principal trading partners, by air and sea. It may, for example, be useful to know which invasive non-native species are present in and around the source of major trading pathways.

Sub-recommendation 6.6:

The role of existing surveillance inspectors should be broadened to include all non-native species and it is suggested that, consideration should be given to putting in place surveillance of movements of non-native species within Britain, in tandem with enforcement and public awareness measures, for invasive species that are causing serious damage.

Sub-recommendation 6.7:

Priority should be given to developing specific mechanisms to monitor the arrival and establishment of marine/aquatic invasive non-native species around British ports.

Sub-recommendation 6.8:

A full audit should be undertaken to determine where the most significant 'gaps' lie in the capacity to monitor the spread of non-natives. In assisting the development of these schemes, it is suggested that priority should be accorded to those schemes covering taxa or habitats that are known to be vulnerable to invasion by non-native species.

Sub-recommendation 6.9:

Government should seek support the development of recording schemes for taxa that possess invasive qualities for which there is currently insufficient means to monitor their establishment and spread, through capacity building of appropriate NGOs or volunteers.

Sub-recommendation 6.10:

Government should encourage the organisers of all biological recording schemes to gather data on the status of non-native species.

Sub-recommendation 6.11:

Recommend the National Biodiversity Network is the obvious route through which data on non-native species from across Great Britain can be made available.

Sub-recommendation 6.12:

A single organisation should have responsibility for co-ordinating the collation of data on non-native species to ensure that they are used in revisions of risk assessments and strategies for the control or management of problem species.

Sub-recommendation 6.13:

Support should be provided to enable biological recording schemes to produce, regular reviews of the status of non-native species.

Sub-recommendation 6.14:

Statutory conservation agencies and NGOs should collaborate to ensure that biological atlases include data collection on non-native species, and that government funding is available to support their production.

Sub-recommendation 6.15:

Resources should be directed towards monitoring the impacts of invasive non-native species on the most threatened species and habitats.

Sub-recommendation 6.16:

Control programmes should always include resources to monitor the population demography of the target species, and the effectiveness of control programmes. This should continue beyond the end of management measures, in order to determine that further invasion has not occurred and that the problem has been resolved.

- **Key Recommendation 7: Policies should be established with respect to management and control of invasive non-native species currently present or newly arrived in the wild, and operational capacity be developed to implement these policies.**

Sub-recommendation 7.1:

A structured approach to assess the impact and management of individual invasive non-native species should be developed. This should include impact assessment, cost estimation and cost-benefit analyses to agreed criteria. The output should accommodate a range of management options from review through limitation to control. These methods should include economic, biodiversity, social, animal welfare and animal and human health considerations. These analyses should provide criteria from which to prioritise actions relating to different species.

Sub-recommendation 7.2:

Co-ordinated methods of risk assessment and control should be established with other countries and across sectoral groupings to assess future risks, limit spread and share expertise.

Sub-recommendation 7.3:

Individual agencies should be nominated to produce and implement management plans for dealing with particular invasive non-native species. Risk assessments and contingency plans should be prepared for species identified as likely to enter the country or to pose particular risks in advance of their arrival. Agencies should be empowered to act in advance of the species entering the country to ensure a rapid and co-ordinated response before the species becomes established. These agencies should also include a contingency capability to deal with the unexpected occurrence of species or species that cross existing sectoral responsibilities.

Sub-recommendation 7.4:

Strategic funding should be made available to support the development of novel control techniques for invasive non-native species and the establishment of centres of excellence for such methods.

Sub-recommendation 7.5:

Research should be conducted into the restoration of habitats or communities following the removal of invasive non-native species to restore their original biodiversity or economic value.

Sub-recommendation 7.6:

Methods of information transfer should be developed, through web-sites, email discussion groups, workshops and conferences, to disseminate information on effective control methods, both nationally and internationally.

- **Key recommendation 8: Stakeholders should be fully consulted and engaged in development of invasive non-native species policies and action through a mechanism such as a consultative forum.**

Other miscellaneous recommendations:**Miscellaneous recommendation 1:**

The precautionary approach is fundamental to dealing with issues arising from invasive non-native species and should always be taken into account in policy development and decision-making.

Miscellaneous recommendation 2:

The Government should continue to work through international mechanisms to improve the regulatory and policy framework for dealing with invasive non-native species issues. This should include input to the Convention on Biological Diversity, the International Plant Protection Convention, the International Maritime Organization's work to address unintentional introduction of marine non-native species through ballast

water transfer, the International Civil Aviation Organisation's consideration of unintentional introduction of non-natives via aircraft, the Bern Convention's work on a European approach and also the European Commission's work to consider how the EC Wildlife Trade Regulations might best be used to address invasive non-native species issues.

Miscellaneous recommendation 3:

Consideration should be given to licensing arrangements for the rehabilitation and release of certain invasive non-native species where this can be undertaken without risk of significant adverse consequences.

Annex 3 Membership of Non-native Species Policy Review Group

The Review Group was first convened on 18 June 2001, comprising representatives from various relevant sectors both governmental and non-governmental (a full list of the organisations represented can be found below).

Department for Environment, Food and Rural Affairs
Department of Trade and Industry*

Scottish Executive
National Assembly for Wales

Maritime and Coastguard Agency*
British Waterways
Central Science Laboratory
Countryside Council for Wales
English Nature
Environment Agency
Forestry Commission
Joint Nature Conservation Committee
Scottish Natural Heritage
National Environmental Research Council*
Scottish Environmental Protection Agency*

Horticultural Trades Association
Kew Gardens
Marine Conservation Society*
Plantlife
Royal Society for the Prevention of Cruelty to Animals
Scottish Society for the Prevention of Cruelty to Animals
The Wildlife Trusts
Wildlife and Countryside Link
Zoos Forum
Association of National Parks*
Centre for Aquatic Plant Management*
Country Land and Business Association*
Local Government Association*
Ornamental Aquatic Trade Association
The Pet Care Trust
The National Botanic Garden of Wales*
The National Farmers Union*
The Salmon and Trout Association*
Gardening Which?*
University of Liverpool*
The Royal Horticultural Society*
The National Marine Aquarium*

*indicates corresponding member of the Review Group

The main group met a total of seven times before finalising this report. Due to the specialist nature of much of the work, it was necessary to convene smaller expert sub-groups to consider elements of the review's work programme in detail. The sub-groups comprised some members of the main Working Group and also further members with relevant expertise.

Expert sub-groups were set up to consider the following areas in detail:

- Prevention
- Monitoring and risk assessment
- Remedy and control

Each of these sub-groups reported back to the main group with recommendations to address each specific area.

To assist the work of the Review Group, Defra commissioned an initial literature study to identify current statutory or non-statutory procedures for dealing with the introduction and establishment of invasive non-native species; to summarise the UK's international obligations to prevent the release of non-natives or to control them where they have escaped; and to gather information and assess the level of success of regimes to control invasive non-natives which exist in other EU states or in countries such as New Zealand or the US who are known to be acting against this problem. The study was useful in clarifying the existing legislative framework, including the relevant various international conventions and agreements. The report of this literature study (Review of Non-native species legislation and guidance, Fasham and Trumper, 2001) is available separately from Defra.

Acknowledgements

The Review Group Secretariat would like to thank everyone involved in the review for their contribution and assistance in compiling this report.

Steve Ashby, Department for Environment, Food and Rural Affairs
Ian Bainbridge, Scottish Executive (Chair – Monitoring and risk assessment sub-group)
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Paul Beckwith, British Waterways
Louise Bardsley, The Wildlife Trusts
Colin Booty, RSPCA
Penny Bramwell, Department for Environment, Food and Rural Affairs
Jonathan Briggs, British Waterways
Roddie Burgess, Forestry Commission
Ray Cannon, Central Science Laboratory
John Clorley, Department for Environment, Food and Rural Affairs
Jim Collins, Pet Care Trust and Sustainable Users Network
Keith Davenport, Ornamental Aquatic Trade Association Ltd
Nicola Donlon, National Assembly for Wales
Andrew Douse, Scottish Natural Heritage
Joanna Drewitt, Scottish Executive

Annex 3 Membership of Non-native Species Policy Review Group

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Sam Fanshawe, Marine Conservation Society/Wildlife and Countryside LINK
Mike Flynn, Scottish Society Prevention of Cruelty to Animals
Mary Gibby, Royal Botanic Garden Edinburgh
Steve Gibson, Joint Nature Conservation Committee
David Gilchrist, Horticultural Trades Association
Paul Gill, Zoos Forum
Sally Gregory, Central Science Laboratory
Madeleine Groves, Royal Botanic Gardens Kew
Martin Harper, Plantlife
Sean Hathaway, Swansea City Council
Will Hellon, Department for Environment, Food and Rural Affairs
Liz Howe, Countryside Council for Wales
John Hounslow, Department for Environment, Food and Rural Affairs
Julian Hughes, RSPB/Wildlife and Countryside LINK (Vice Chair Monitoring and risk assessment sub-group)
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Stephen North, Scottish Natural Heritage
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Pete Robertson, Central Science Laboratory (Chair Remedy and Control Sub-group)
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Ian Russell, The Centre for Environment, Fisheries and Aquatic Science
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Duncan Williams, Department for Environment, Food and Rural Affairs
Robert Willows, Environment Agency
Sharon Wort, Maritime and Coastguard Agency
Iain Ormerod, Ministry of Defence

Alien species: see “non-native species”. “Alien species” is the equivalent term to “non-native species” used by the Convention on Biological Diversity. The term “invasive alien species” is therefore equivalent to “invasive non-native species”.

Aquaculture: the cultivation of aquatic plants or animals, either within containers or free-living.

Archaeophyte: An archaeophyte is a plant which became naturalised before AD 1500. (Preston, C.D., Pearman, D.A. & Dines, T.D. (2002)).

Casual: A casual is a plant which is present only as populations which fail to persist in the wild for periods of more than approximately five years, and such a species is therefore dependent on constant re-introduction. (Preston, C.D., Pearman, D.A. & Dines, T.D. (2002)).

Code of conduct: a formalised code of best practice to address (in the context of this report) existing or potential problems from the introduction of non-native species. Such codes should be formally established by agreement with the various sectors and interests concerned with invasive non-native species, and be underpinned by appropriate legislation or agreements to ensure compliance.

Ecosystem approach: An ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Refer to Chapter 2.2.

Establishment: refers to the process of a non-native species in a new habitat successfully producing viable offspring with the likelihood of continued survival.

Hitch-hikers: organisms that disperse in association with other species, for example, through being attached to the outside of plants or animals.

Introduction: the deliberate or accidental release of an organism(s) into the wild in areas (*e.g.* country, region, site, *etc.*) where the species or race is not native. This movement can be either within a country or between countries or areas beyond natural jurisdiction. Intentional and unintentional introductions are further explained below.

Intentional introductions: refers to the deliberate movement and/or release by humans of a non-native species outside its natural range.

Invasive non-native species: means a non-native species whose introduction and/or spread threatens biological diversity. This is interpreted broadly to include threats to the entire ecosystem including human interests (*e.g.* including threats to public health and financial damage).

Mariculture: the cultivation of marine plants or animals in the sea, either within containers or free-living.

Native species: A species or race which occurs naturally in an area, in this case Great Britain. Often this is qualified by the addition of a cut-off date (*e.g.* since 1600).

Neophyte: A *neophyte* is a plant which was first introduced after 1500, or was only present as a casual before 1500 and is naturalised now only because it was re-introduced subsequently. (Preston, C.D., Pearman, D.A. & Dines, T.D. (2002)).

Non-native species: refers to a species, subspecies or lower taxon, introduced (*i.e.* by human action) outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.

Precautionary principle/approach: is a formal recognition of the act of being cautionary when making decisions. The precautionary approach is described in the preamble to the CBD and in Article 15 of the Rio Declaration. Refer to chapter 2.2.

Reintroduction: the deliberate or accidental release of a living organism(s) into the wild to areas (*e.g.* country, region, site, etc.) where the species or race was native but has become extinct.

Risk analysis: in the field of non-native species issues, the process whereby the chances of a particular non-native species causing problems after introduction to a country are assessed, based upon previous knowledge of the behaviour of the species and its relatives in its native range and after any introductions carried out elsewhere. The CBD defines this as referring to: (1) the assessment of the consequences of the introduction and of the likelihood of establishment of an alien species using science-based information (*i.e.*, risk assessment), and (2) to the identification of measures that can be implemented to reduce or manage these risks (*i.e.*, risk management), taking into account socio-economic and cultural considerations.

Translocation: a general term for the transfer by human agency of any organism(s) from one place to another.

Unintentional introductions: the introduction of non-native species as the accidental or incidental consequence of human activities. This is not the same as introductions deriving from natural dispersal processes, although for some species it may be hard to distinguish unintentional introductions from natural colonisation events.

The indication of the possible level of risk for the pathways in table 1 is only an informal assessment from the Prevention sub-group and does not represent an in depth risk assessment of these pathways. The risks associated with different vectors and groups of organisms have been allocated to three subjective categories in the report as follows.

Low risk: there is only a small chance (less than one species per decade) of non-native species becoming established and causing problems, based upon previous experience in Britain.

Medium risk: there is a moderate chance (one or more species per decade, but less than one species per year) of non-native species becoming established and causing problems, based upon previous experience in Britain.

High risk: there is a large chance (more than one species per year) of non-native species becoming established and causing problems, based upon previous experience in Britain.

Groups of organisms	Pathway	Prevention measures
Marine 1	Shipping: organisms in ballast water. Risk: high	Internationally agreed codes of conduct for ballast water exchange. Requires international co-operation to promote agreed practices, train crews, and for effective surveillance for compliance.
Marine 2	Shipping: organisms on hulls, anchors <i>etc.</i> Risk: medium	Prophylactic sanitary measures are essential but difficult to apply.
Marine 3	Mariculture: importation of livestock (fish and shellfish <i>etc.</i>) carries risks of associated diseases or other organisms arriving. Risk: high	Prevention at source of exports is difficult to achieve. Needs codes of conduct for importers, coupled with inspection and prophylactic treatment of stock to eradicate diseases or hitch-hikers.
Marine 4	Marine aquaria (public and private): accidental discharge of organisms in water from aquaria. Risk: medium	Treatment of water before discharge into the sea. Needs guidance to aquarists and best practice solutions, coupled with spot inspections to ensure compliance.
Marine 5	Tourism: accidental importation of species in or on boats. Risk: medium	Publicity and education directed towards tourists and/or their crews, regarding any risks, coupled with surveillance to detect any new risks from changes in the tourism sector or in the design and operation of boats.

Table 1 Pathways for unintentional introductions of non-native species (*continued*)

Groups of organisms	Pathway	Prevention measures
Freshwater 1	Shipping: organisms on hulls, anchors <i>etc.</i> Risk: medium	Prophylactic sanitary measures are essential but difficult to apply.
Freshwater 2	Tourism: accidental importation of species in or on boats. Risk: medium	Publicity and education directed towards tourists and/or their crews, regarding any risks, coupled with surveillance to detect any new risks from changes in the tourism sector or in the design and operation of boats.
Freshwater 3	Aquaculture: importation of livestock (fish and Crustacea <i>etc.</i>) carries risks of associated diseases or other organisms arriving. Risk: high	Prevention at source of exports is difficult to achieve. Needs codes of conduct for importers, coupled with inspection and prophylactic treatment of stock to eradicate diseases or hitch-hikers.
Freshwater 4	Angling: the translocation of fish or live bait can result in the movement of diseases or other organisms. Risk: high	Codes of conduct for translocating fish or live bait, coupled with appropriate inspections and legislation to ensure compliance.
Freshwater 5	Horticulture: importation and translocation of aquatic plants can result in the movement of diseases or hitch-hikers. Risk: high	Prevention at source of exports is difficult to achieve. Needs codes of conduct for importers, coupled with inspection and prophylactic treatment of stock to eradicate diseases or hitch-hikers.
Freshwater 6	Gardening: aquatic plants and associated organisms can disperse from garden ponds or other locations. Risk: high	Prevent sale of non-native species known to cause problems and supply educational materials on the design, construction and maintenance of ponds that reduce the chances of dispersal.
Freshwater 7	Freshwater aquaria (public and private): accidental discharge of organisms in water from aquaria. Risk: medium	Treatment of water before discharge. Needs guidance to aquarists and best practice solutions, coupled with spot inspections to ensure compliance.
Freshwater 8	Escapes: can be due to flooding of ponds <i>etc.</i> Risk: high	Ensure that damaging non-native species are not held in places liable to flooding through codes of conduct and/or licensing. Improve containment techniques and standards where ponds are liable to flooding.
Freshwater 9	Waste disposal: discharges of sewerage and other wastes can contaminate freshwaters with non-native species. Risk: medium	Raise standards for waste treatment and ensure compliance through codes of conduct.

Table 1 Pathways for unintentional introductions of non-native species (*continued*)

Groups of organisms	Pathway	Prevention measures
Terrestrial 1	Trade and movement of goods: species can be translocated in containers, packing materials, in or on plants (or in associated compost), on timber with or without bark or in some food products. Risk: high	Review inspection and sampling regimes and ensure consistent checks of goods which pose the greatest risks of concealing non-native species. Institute prophylactic treatments where appropriate to reduce entry of damaging species (including pests and diseases).
Terrestrial 2	People movements: for business and tourism via aeroplanes, cars, rail and ships. Risk: high	Review customs and other checks; raise awareness of risks through education; institute prophylactic treatments where appropriate to reduce entry of damaging species (including pests and diseases).
Terrestrial 3	Escapes: organisms can escape while in transit through accidents or negligence. Risk: medium	Degree of containment and procedures for handling organisms in transit should be reviewed and best practice guidance issued, with subsequent spot checks for compliance.
Terrestrial 4	Military movements: the transport of personnel and their equipment can result in the translocation of plants, animals, pests and diseases. Risk: medium	The bio-security policies that are produced by the Ministry of Defence for all military deployments couple to their disciplined approach to enforcement, give assurance that risks of translocating plants, animals, pests and diseases have been minimised.

Table 2 Pathways for intentional introductions of non-native species

Groups of organisms	Pathway	Prevention measures
Marine 1	For mariculture (fish, molluscs and crustaceans)	Licensing of introductions; carry out risk assessment for new species; ensure freshly imported stocks are disease-free; conduct surveillance after introductions to check for problems.
Marine 2	Discards from cultivation or captive stocks	Codes of conduct to bring in better practices for handling and disposing of captive or contained stocks of marine organisms. Highlight potentially damaging species that do not yet occur in Britain.
Marine 3	Waste disposal	Improved surveillance for potential problems coupled with possibly stronger regulations and new codes of practice to reduce the risks.

Table 2 Pathways for intentional introductions of non-native species (*continued*)

Groups of organisms	Pathway	Prevention measures
Freshwater 1	For aquaculture (fish and crustaceans)	Review current legislation for effectiveness in preventing problems and amend as required. Increase education and strengthen codes of conduct.
Freshwater 2	For gardening/horticulture	Review current legislation for effectiveness in preventing problems and amend as required (possibly to bring plants more in line with animals in terms of a general prohibition on release of non-native species).
Freshwater 3	For angling (fish, live bait species and disease organisms)	Promulgate new codes of practice via angling organisations to reduce the number of non-native species dispersed via these activities. Highlight potentially damaging species that do not yet occur in Britain.
Freshwater 4	Discards from cultivation or captive stocks	Codes of conduct to bring in better practices for handling and disposing of captive or contained stocks of freshwater organisms. Highlight potentially damaging species that do not yet occur in Britain.
Freshwater 5	Waste disposal	Improved surveillance for potential problems coupled with possibly stronger regulations and new codes of practice to reduce the risks.
Terrestrial 1	For agriculture	Few crops or livestock species have caused problems hitherto. Review potential risks and establish codes of conduct where these are necessary to supplement the existing legislation. Highlight potentially damaging species that do not yet occur in Britain.
Terrestrial 2	For forestry	Few forest species have caused problems hitherto (although there has been some movement of different genotypes beyond their native range, or unintentional spread of non-natives). Highlight potentially damaging species that do not yet occur in Britain.
Terrestrial 3	For habitat restoration or landscaping	The major issue is importation of non-native genotypes of native plants, with inappropriate use of non-native plants in some situations. The issue of non-native genotypes needs to be investigated further, with a possible case to go to Europe on the application of current trade regulations within the EC (which is also a conservation problem in other European countries). Highlight potentially damaging species that do not yet occur in Britain.

Table 2 Pathways for intentional introductions of non-native species (*continued*)

Groups of organisms	Pathway	Prevention measures
Terrestrial 4	For biological control	Current legislation is tight; increased education may be needed to raise awareness of potential benefits and problems.
Terrestrial 5	For gardening/horticulture	Review current legislation for effectiveness in preventing problems and amend as required (possibly to bring plants more in line with animals in terms of a general prohibition on release of non-native species).
Terrestrial 6	For shooting/wildfowling	Use the current law to ensure that no inappropriate quarry or game species are imported and released in future.
Terrestrial 7	For biodiversity conservation (<i>i.e.</i> reintroductions)	'Introductions' for biodiversity conservation are usually reintroductions of historically native species, and should be subject to a similarly critical evaluation (<i>e.g.</i> based on the IUCN guidelines). A JNCC/ Country Agency draft policy has been consulted upon. This is a basis for shaping future practices in this area.
Terrestrial 8	For aesthetic/cultural reasons	Increase education and awareness of the problems from non-native species and the current legal position in order to make such introductions less likely and less acceptable to the general public.
Terrestrial 9	Released pets or domestic animals	Increase education and awareness of the problems from non-native species and the current legal position at the point of sale and in appropriate media and magazines. Highlight potentially damaging species that do not yet occur in Britain.
Terrestrial 10	Waste disposal	Improved surveillance for potential problems coupled with possibly stronger regulations and new codes of practice to reduce the risks.

1.1 Initiation

Initiation covers the factors that need to be considered before starting a risk assessment and the various ways in which such assessments may be triggered.

1.2 Reasons for initiating a risk assessment

The reason for initiating a risk assessment should always be given at the onset of the process.

Risk assessments may be initiated as a result of:

- a proposal for the intentional introduction of a non-native species
- the identification of a non-native species that may be unintentionally introduced
- the identification of a pathway or pathways that could allow non-native species introductions
- the review or revision of non-native species management actions, policies or priorities
- a requirement to assess the vulnerability of particular receptors, including native species, habitats or ecosystems, to non-native species

1.3 Distribution of non-native species and receptors selected for risk assessment

Risk assessments can be undertaken on any non-native species, whether absent from the area under consideration, present but only in managed or contained environments, present but not widespread or present and widespread.

Risk assessments for present and widespread non-native species are most likely to be conducted to determine the extent to which actions and policies are effective in minimising damage or to predict future changes to distribution and impacts, *e.g.* as a result of climate change. The procedures used to assess the risks posed by widespread non-native species can also be used for native species. This means that, although there is no agreed method for distinguishing between native and non-native species, risk assessments can still be undertaken without first having to decide into which group a species lies. Risk assessments can also be undertaken for species which were previously native but have died out and are being proposed for reintroduction.

1.4 Area covered by the risk assessment

The area may be a whole country, part of a country or all or parts of several countries. It should always be defined before starting a risk assessment, and this definition will depend on the context of the risk assessment. In the case of risk assessments for intentional introductions, a distinction may be made between the intended and the unintended areas, and both these areas will need to be defined. The risk assessment procedure itself is designed to highlight the areas at greatest risk. In cases where the introduction may be a biological control agent to control an invasive species, the risk of not introducing the organism may need to be considered.

1.4 Examples of risk assessment initiations

The IPPC (International Plant Protection Convention) International Standard on Pest Risk Analysis (FAO 2001) lists 18 different ways in which risk assessments may be triggered. These are repeated below with additions to cover intentional introductions and to highlight natural pathways and receptors. Examples based on British experience are given.

Initiation by species	Example
An intentional introduction of a non-native species is proposed	<i>Miscanthus</i> biomass crop
An emergency arises due to the discovery of an infestation or outbreak of a non-native species new to an area	Mink in the Hebrides
A change occurs in the distribution or invasiveness of non-native species already present in an area	Muntjac
A species new to an area is intercepted	Asian longhorn beetle on solid wood packing material from China
A new species risk is identified by research	Ruddy duck
A species is introduced into an area outside its normal distribution	Hedgehog in the Hebrides
A species introduced to an area outside its normal distribution is reported to be damaging	Incidence of sudden oak death in California led to assessment of the risks posed to UK oaks.
Repeated interceptions of a species occurs	Colorado beetle
A request is made to import a species for research, breeding or to be kept in captivity	Mink
An organism is identified as a vector for other species	North American signal crayfish as a vector of crayfish plague (<i>Aphanomyces astaci</i>)
An organism is genetically altered in a way which may influence its invasiveness	Formation of the amphidiploid <i>Spartina anglica</i> from <i>Spartina x townsendii</i> .
Initiation by Pathway	
International trade is initiated in a commodity new to the country	<i>Miscanthus</i> biomass crop
Existing trade in non-native species for consumption, cultivation, breeding or research is reviewed	Horticulture, agriculture, forestry, aquaculture, pet industry
An international trade activity which may lead to the unintentional introduction of non-native species is reviewed	Ballast water, soil adhering to machinery, contamination of food
A non-trade pathway associated with human transport is reviewed	Exotic items brought in as baggage by travellers, deliberately or inadvertently
The importance of introduction of a non-native species by natural spread needs to be assessed	Potential natural spread of Indian house crow from Holland (where it has been introduced accidentally by man) to UK

Initiation by management action	
The importance of introduction of a non-native species by natural spread needs to be assessed	Potential natural spread of Indian house crow from Holland (where it has been introduced accidentally by man) to UK
A national decision is taken to review regulations, requirements or operations	Wildlife Legislation
A proposal made by another country or an international organisation is reviewed.	Implications of the Convention on Biological Diversity Guiding Principles on Invasive Alien Species
A new treatment or loss of a treatment system, a new process, or new information impacts on an earlier decision.	A new herbicide is approved for use
A dispute arises	Action taken to prevent pine wood nematode entering Europe on North American logs leads to a trade dispute
Major national or international changes occur in the non-native situations or borders of a country	UK devolution
Initiation by Receptor	
The threat to an endangered native species, habitat or ecosystem needs to be assessed	Lundy cabbage (from rhododendron)
The threat to a native keystone species needs to be assessed	English elm (from Dutch elm disease)
The threat to another species valuable to man needs to be assessed	Earthworms (from New Zealand flatworm)

Expert advice

Expert advice may be required when undertaking a risk assessment to help understand the procedures used in risk assessment, to provide relevant information on the species, habitats, ecosystems, pathways, management options and policies concerned, to describe previous experience and to give opinions where information is lacking, incomplete or conflicting.

Information collection

In some circumstances, *e.g.* where there is a dispute or known complexity, a risk assessment will require the collection and assimilation of a considerable amount of information before it can be completed satisfactorily. Although some information is clearly needed before a risk assessment can be started, it is often advantageous to conduct a preliminary, brief risk assessment with the information to hand because this will help to identify the magnitude of the task, where the gaps lie and what resource will be required to complete the risk assessment. Brief risk assessments may be all that is required where the situation is clear cut, where there is little time to act or where the objectives of the risk assessment do not require a detailed response. It is essential that an audit trail exists for each risk assessment.

There is a rapidly growing literature on invasive non-native species world-wide which greatly assists with the collection of relevant information and the understanding of risk assessment procedures. Some examples are given below:

Books	Williamson, M. 1996. <i>Biological invasions</i> . Chapman and Hall, London. Child, L & Wade, M. 2000. <i>The Japanese knotweed manual</i> . Packard, Chichester.
Journals	Biological Invasions: http://www.kluweronline.com/issn/1387-3547
Papers	Parker, I.M., Simberloff, D., Lonsdale, W.M., Goodell, K., Wonham, M., Kareiva, P.M., Williamson, M.H., Von Holle, B., Moyle, P.B., Byers, J.E. & Goldwasser, L. 1999. Impact: toward a framework for understanding the ecological effects of invaders. <i>Biological Invasions</i> , 1: 3-19.
CD-ROMs	(CABI) CAB International. 2001. Crop Protection Compendium, Wallingford, UK.
Web sites	Global Invasive Species Database: http://www.issg.org/database/welcome/ IUCN Guidelines: http://www.iucn.org/themes/ssc/pubs/policy/invasivesEng.htm
List servers	Aliens-L

For the UK, a wide variety of resources may need to be consulted depending on the taxa involved.

Books	Clement, E.J. & Foster, M.C. 1994. <i>Alien Plants of the British Isles</i> . Botanical Society of the British Isles, London
Papers	Manchester, S.J. & Bullock, J.M. 2000. The impacts of non-native species on UK biodiversity and the effectiveness of control. <i>Journal of Applied Ecology</i> , 37: 845-864.
Web sites	http://www.invasiveweeds.co.uk/ Advisory Committee on Releases to the Environment: http://www.defra.gov.uk/environment/acre/index.htm

In addition to biological information on non-native species, the risk assessment may require other information, e.g. on the climate of the area concerned (Barrow *et al.*, 1993).

Monitoring, surveillance and survey schemes that include non-native species, plus major atlas databases with non-native information

Taxa covered	Analysis for non-natives	Organisation	Database/data Summary	Area covered	Database type/production format	Location of main contact	Periodicity	Notes and comments
All terrestrial and fresh-water species except birds. A few coastal marine species are also included	Yes, though data is variable across taxa (SNH <i>Audit of Alien Species in Scotland</i> produced from this)	Centre for Ecology and Hydrology (CEH)	Biological Records Centre Database	Britain (and occasionally Ireland)	Oracle database	Monkswood	Records from local recorders are sent to the BRC	The data is collected in a slightly <i>ad-hoc</i> way, best described as repeated surveillance rather than monitoring. Since all records are dated, it is possible to produce large scale maps of spread of non-native species. Highlighting the importance of non-native species records to local recorders may improve the frequency and accuracy of data collection.
Vascular plants		SNH	Plant Monitoring in Scotland					
Vascular plants	Yes, including some analysis of distribution and spread	Various including BSBI & BRC	Atlas 2000	Britain and Ireland	Printed output from BRC database	Monkswood	Unknown (likely to be greater than 10 years)	Coverage depends on the crops/commodities targeted for inspection.
Aquatic plants		SNH	Botanical Survey of Scottish Freshwater Lochs (BSSFL)				One off only (unlikely to be repeated).	
Selected species (mostly aquatic plants), especially Japanese knotweed, Himalayan balsam and giant hogweed	None, but possible	Environment Agency (and SEPA)	River Habitat Survey Database	Main rivers throughout UK	Access 97 and Mapinfo	Warrington	Every 10 years	Based on data taken from the RHS throughout the UK. Surveys were conducted on 500m stretches of main river corridors. Surveyors are asked to record certain non-native plant species, but also asked to note the presence of any large patches of plant species. The non-native species list to be recorded is currently being reviewed and expanded.

Monitoring, surveillance and survey schemes that include non-native species, plus major atlas databases with non-native information (cont'd)

Taxa covered	Analysis for non-natives	Organisation	Database/data Summary	Area covered	Database type/production format	Location of main contact	Periodicity	Notes and comments
Aquatic and riparian invasive species (26)	Yes	Environment Agency	Invasive species data base	Thames Region only	Access 97 and Arcview	Reading	Some species annually updated from other EA surveys	They are using BRC data, local regional data and all other information sources from the Thames region including their own EA databases to produce this non-native species distribution maps for the Thames Region.
Macrophytes		CCW	Macrophytes database					
Fresh-water macrophytes, macro-invertebrates, algae; some riparian and marine species including fish, cetaceans and birds	None, but possible	Environment Agency	Biology for Windows	Main rivers throughout England and Wales, though they are considering expanding it to standing waters	Oracle database	Wallingford	Data available since 1972. Varies, depending on taxa – annually for macrophytes and macroinvertebrates for some regions. Quinquennially for most regions and taxa	Data available since 1972. Varies, depending on taxa – annually for macrophytes and macroinvertebrates for some regions. Quinquennially for most regions and taxa. Data collection of macrophytes and macroinvertebrates follows well defined procedures. Every organism is recorded (native and non-native) however not every taxa is taken to species level (for instance some beetles only go to family). In some regions (Anglian for example) the macrophyte and macroinvertebrate surveys are to species. Non-native crayfish surveys are also recorded in this database. The database can be queried on specific species. They are making it accessible via the NBN gateway.
Invertebrates		SNH	Invertebrates Monitoring in Scotland					

Monitoring, surveillance and survey schemes that include non-native species, plus major atlas databases with non-native information (*cont'd*)

Taxa covered	Analysis for non-natives	Organisation	Database/data Summary	Area covered	Database type/production format	Location of main contact	Periodicity	Notes and comments
Invertebrates		SASA	Rothamstead Insect Survey					
Pest' non-native invertebrates	Surveys in relation to specific identified need	FC/FCRA	Plant Health data held by FCPHS	GB	Excel Access	Edinburgh Alice Holt	On basis of identified hazard	General surveillance. Current examples are Asian longhorn beetle (<i>Anoplophora glabripennis</i>), gypsy moth (<i>Lymantria dispar</i>) and horse chestnut leafminer (<i>Cameraria ohridella</i>).
Bark beetles (Coleoptera: Scolytidae)	Specific surveys to assess for presence of <i>Dendroctonus micans</i> and several <i>Ips</i> species of European origin. Also assessment for presence of non-European Scolytidae	FC/FCRA	EU Protected Zone data and reports	GB	Excel Access	Edinburgh Alice Holt	Annual and on demand	Part of EU Protected Zone status. Surveys have to be carried out to demonstrate absence from range of European bark beetles in order to maintain ability to control wood imports from rest of EU.
Invertebrates and pathogens on imported plants and crops	Yes	Plant Health Service	Plant Health Database (computerised since 1987)	UK	Unidata, migrating to SQL Server	York		Interception data cover potential for entry and arrival. Majority of interceptions have been identified to species, have a known host plant and a country of origin. To some extent, data coverage depends on the crops/ commodities targeted for inspection.

Monitoring, surveillance and survey schemes that include non-native species, plus major atlas databases with non-native information (*cont'd*)

Taxa covered	Analysis for non-natives	Organisation	Database/data Summary	Area covered	Database type/production format	Location of main contact	Periodicity	Notes and comments
Butterflies	Non-native species recorded since 1976	CEH? BRC?	Butterfly Monitoring Scheme	UK			Annually	Sites regularly surveyed in a standardised way. Data is reliable, but is mainly from nature reserves and protected sites. The wider countryside is poorly represented. There is also a strong Southern bias in the number of sites
Fresh-water fish (and some marine and estuarine fish, depending on the region)	Yes, for enforcement.	Environment Agency	National Fish Populations Database	England and Wales	Access 97	Thames	Fisheries surveys are annual	Contains, not only presence and absence data but also population size and structure data. Much of the non-native species data is gained from angling press, club catches etc. The systematic surveys take place on 100-200m stretches.
Fresh-water, marine and estuarine fish, their diseases and parasites	Yes, for enforcement of Import of Live Fish Act	Environment Agency and CEFAS	Live Fish Movements Database	England and Wales	SQL 7 database with a visual basic front end, operated through windows NT	Various	Licences as they happen.	The movement of species, species introductions and species releases are recorded here. In addition all licensed health check data is recorded here. This includes the ILFA database. This database is used as both a monitoring and enforcement tool. Data is checked against any reports of non-natives (from press, and general surveys). All licensed non-native fish releases are recorded, not just the species but also numbers and size. Any disease organisms are also reported here. The country of origin of imported species is also recorded.

Monitoring, surveillance and survey schemes that include non-native species, plus major atlas databases with non-native information (*cont'd*)

Taxa covered	Analysis for non-natives	Organisation	Database/data Summary	Area covered	Database type/production format	Location of main contact	Periodicity	Notes and comments
All marine taxa within survey plots, including non-natives	None, but possible	Environment Agency	National Marine Monitoring Programme	87 sites mainly in impacted estuaries, but some further out to seaUK		National Centre for Env Data & Surveillance, Bath	Annually	Known host plant and a country of origin. To some extent the data.
Various marine species	Selected non-native species are targeted for public awareness and for the monitoring programme	MBA, MarLIN and PADI	Marine Life Awareness Programme					Volunteer recorder programme.
Breeding birds (including common non-natives)	None specifically, but trends produced for all species that occur in more than 40 1-km squares.	British Trust for Ornithology	Breeding Birds Survey	UK	Fixed length text files. Data analysed by SAS programmes	Thetford	Annually	Potential to analyse species distributions on a 1km square basis. Can provide numbers and distribution of species from 1994 onwards. The database is currently difficult to use. They are hoping to put the data onto a relational database in the future.
Wetland birds (particularly non-breeding)	Yes, annual count for each species published	Wildfowl & Wetlands Trust	Wetland Bird Survey (WeBS)	UK	Database currently under revision. Some in Paradox, Oracle and various formats	Slimbridge	Annually	Monthly counts of wildfowl and waders at sites throughout the UK.

Monitoring, surveillance and survey schemes that include non-native species, plus major atlas databases with non-native information (cont'd)

Taxa covered	Analysis for non-natives	Organisation	Database/data Summary	Area covered	Database type/production format	Location of main contact	Periodicity	Notes and comments
All non-native breeding birds (except the very abundant, e.g. Pheasant)	Yes, annual report produced	Rare Breeding Birds Panel	Rare Breeding Birds Panel	UK	Paradox database	Bruich-laddich, Islay	Annually	Non-systematic data recording, but does pick up early arrivals of breeding birds. Relies on County Recorders, data comes from county bird reports. County bird recorders fill in special reports.
All larger species	Impacts of invasive species noted, but no analysis	SNH, CCW, EN	Site Condition Monitoring Programme	Designated sites	?	Annual (six year rolling programme)		On a six year rolling programme. Non-native species are recorded if they become an issue for the special features of designated sites
Mammals	None	JNCC	MAM-ONET	UK	Not yet decided	Peterborough	Planned to surveys annually	This is currently at the pilot phase. Intention is to carry out some surveillance on all mammals. Currently prioritising BAP species, and other species of conservation concern. Looking at signs and road death records. Looking at DNA reference library for all info National Bat monitoring programme (8 species) will be included within this. Plan is to look at population trends over time.
Bats			National Bat Monitoring Programme					
Amphibians and reptiles		HCT						

Entry potential

How many pathways could the pest be carried on?

How likely is the pest to be associated with the pathway at origin?

Is the concentration of the pest on the pathway at origin likely to be high?

How likely is the pest to survive existing cultivation or commercial practices?

How likely is the pest to survive or remain undetected during existing phytosanitary procedures?

How likely is the pest to survive in transit?

How likely is the pest to multiply during transit?

How large is movement along the pathway?

How widely is the commodity to be distributed through the Pest Risk Assessment (PRA) area?

How widely spread in time is the arrival of different consignments?

How likely is the pest to be able to transfer from the pathway to a suitable host?

Is the intended use of the commodity likely to aid introduction?

Establishment potential

How many host plant species are present in the Pest Risk Assessment (PRA) area?

How extensive are the host plants in the PRA area?

If an alternate host is needed to complete the life cycle, how extensive are such host plants in the PRA area?

If a vector is needed for dispersal, how likely is the pest to become associated with a suitable vector?

Has the pest been recorded on crops in protected conditions elsewhere?

How likely are wild plants to be significant in dispersal or maintenance of populations?

How similar are the climatic conditions that would affect pest establishment in the PRA area and in the area of origin?

How similar are other abiotic factors in the PRA area and in the area of origin?

How likely is the pest to have competition from existing species in the PRA area for its ecological niche?

How likely is establishment to be prevented by natural enemies already present in the PRA area?

If there are differences in the crop environment in the PRA area to that in the area of origin, are they likely to aid establishment?

Are the control measures which are already used against other pests during the growing of the crop likely to prevent establishment of the pest?

Is the reproductive strategy of the pest and duration of life cycle likely to aid establishment?

How likely are relatively low populations of the pest to become established?

How probable is it that the pest could be eradicated from the PRA area?

How genetically adaptable is the pest?

How often has the pest been introduced into new areas outside its original range?

Economic impact assessment

How important is economic loss caused by the pest within its existing geographic range?

How important is environmental damage caused by the pest within its existing geographic range?

How important is social damage caused by the pest within its existing geographic range?

How extensive is the part of the PRA area likely to suffer damage from the pest?

How rapidly is the pest liable to spread in the PRA area by natural means?

How rapidly is the pest liable to spread in the PRA area by human assistance?

How likely is it that the spread of the pest could be contained within the PRA area?

Considering the ecological conditions in the PRA area, how serious is the direct effect of the pest on crop yield and/or quality likely to be?

How likely is the pest to have a significant effect on producer profits due to changes in production costs, yields etc. in the PRA area?

How likely is the pest to have a significant effect on consumer demand in the PRA area?

How likely is the presence of the pest in the PRA area to affect export markets?

How important would other costs resulting from introduction be?

How important is the environmental damage likely to be in the PRA area?

How important is the social damage likely to be in the PRA area?

How probable is it that natural enemies, already present in the PRA area, will affect populations of the pest if introduced?

How easily can the pest be controlled?

How likely are control measures to disrupt existing biological or integrated systems for control of other pests?

How likely are control measures to have other undesirable side-effects?

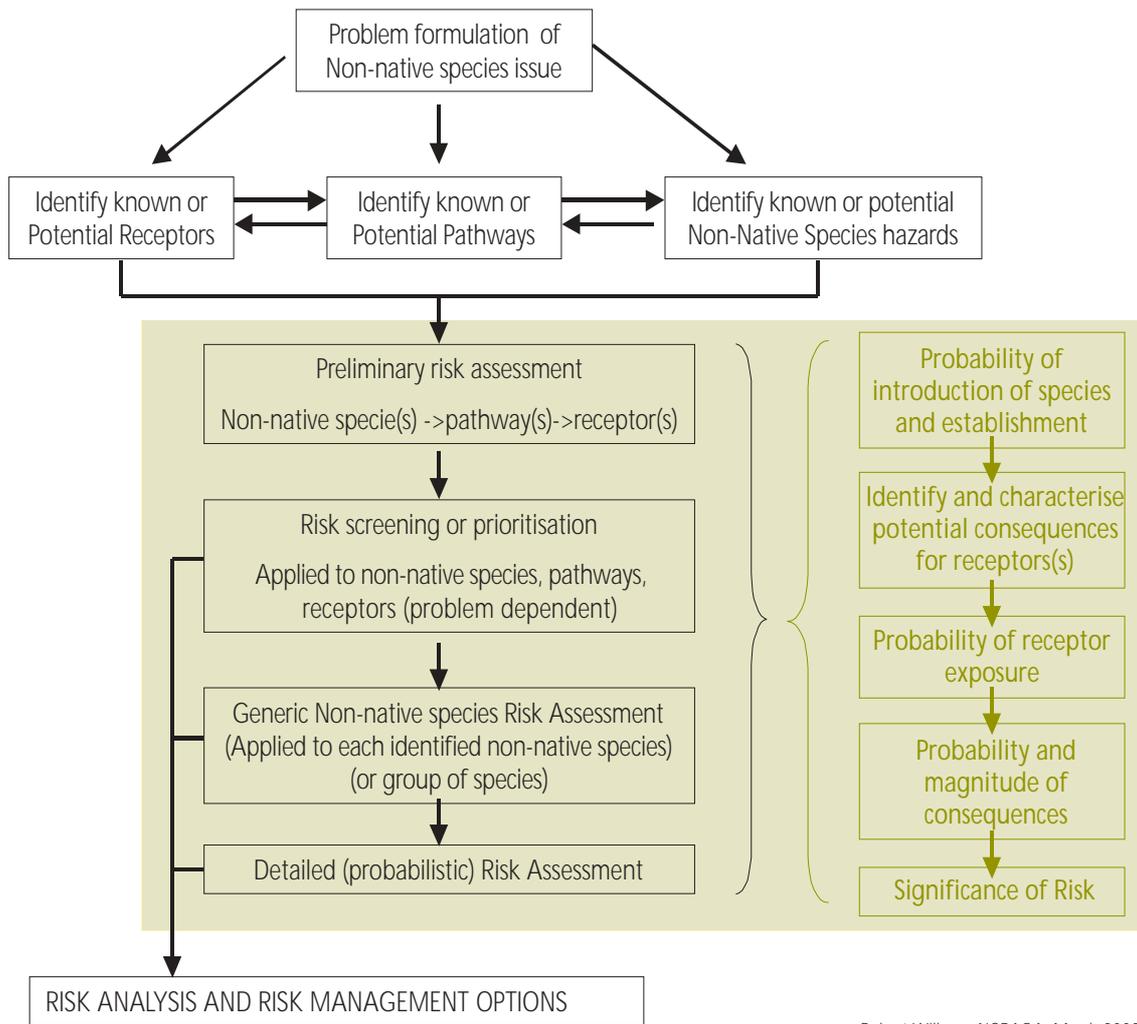
Is the pest likely to develop resistance to plant protection products?

The following conclusions were drawn after discussions by the Review Group on the value of the EPPO risk assessment scheme for four species (*Azolla filiculoides*; *Corvus splendens*, *Muntingia calabura*, and *Uncinia rubra*):

- the EPPO Risk Assessment can be used to assess the risks posed by non-native species but it requires modification. For example, questions must be modified to deal with non-pest species;
- additional questions may be needed to assess key features which are only important for specific taxa. For example, the ability to reproduce vegetatively, *e.g.* by rhizomes, and the need for specialist pollinators are relevant only for the assessment of plant taxa. Consideration may need to be given to producing different versions for different taxa, to overcome the differences in ecological and biological requirements;
- when considering an intentional introduction, the questions under entry potential need not be answered;
- when assessing a species which is already present and widespread, the questions on entry potential and establishment potential need not be answered unless the potential for future expansion of a species distribution is being assessed;
- the scheme is written so that only one species is assessed at a time. Additional pathways for this species can also be explored. To conduct an assessment of all species which may be transported along a pathway, be affected by a change of policy or may harm receptors, these assessments will have to be combined;
- the individual completing the questionnaire should be an expert in the organism and may need support from experts in risk assessment, potential receptors, and others;
- to help promote consistency between users of the questionnaire it could be supported by more detailed guidance on the purpose of individual questions, and what might constitute appropriate answers;
- the purpose of completing the risk assessment has to be clear from the outset, *e.g.* to inform a management plan or to create a priority list;

- the definition of the area to be covered by the risk assessment depends on its purpose, but should include consideration of the distribution of the receptors at risk, and the potential distribution of the non-native species. Guidance is required to ensure appropriate definition of the area considered by the risk assessment;
- the scheme assumes that an assessment commences with an identified non-native species that represents a potential risk. To accommodate assessments that aim to identify the species that represent a risk to particular receptors, or the risk posed by pathways of introduction, modifications to the order in which sections are completed should be considered;
- it would be useful if the risk assessment included a question about public awareness of the presence of the organism;
- the scheme stresses the need for knowledge of species' behaviour in other countries.

The risk assessment should include an assessment of the potential difficulty for control in the event of an escape.



Robert Willows, NCRAOA, March 2002

Prepared by remedy and control sub-group (please note: this is for illustrative purposes and should not be regarded as an exhaustive list)

PLANT HEALTH	Implementation of EU Plant Health legislation throughout the UK. It also administers Plant Health in England	Plant Health Division, Defra, Foss House, Peasholme Green York, YO1 7PX
	Technical enforcement in support of Plant Health Division in England and Wales	Plant Health & Seeds Inspectorate (PHSI of the PHD), Defra, Foss House, Peasholme Green, York, YO1 7PX
	Technical advice in support of Plant Health Division	Plant Health Group, Central Science Laboratory, Sand Hutton, York, YO41 1LZ
	The National Assembly for Wales Agriculture Department (NAWAD) has responsibility for the administration of plant health legislation in Wales (with PHSI and CSL providing technical support on an agency basis)	AWAD, Govt Bldgs, Spa Road East, Llandrindod Wells, LD1 5HA
	Scottish Executive Environment & Rural Affairs Department (SEERAD) has responsibility for the administration of plant health legislation in Scotland and has its own inspectorate	SEERAD, Pentland House, 47 Robbs Loan, Edinburgh, Scotland, EH14 1TW
	Technical advice in support of SEERAD	Scottish Agricultural Science Agency (SASA), East Craigs, Craigs Road, Corstorphine, Edinburgh, EH12 8NJ
TREE HEALTH	National responsibility for administration of the Forest Tree Order and their harmful organisms is the responsibility of the Forestry Commission (FC) which has its own plant health inspection service	Forestry Commission, 231 Corstorphine Road, Edinburgh, EH12 7AT
	Provision of technical support to the Forestry Commission	Forest Research, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, GU10 4LH
FISH AND SHELLFISH	Defra has responsibility for administration of SFFA, WCA and ILFA measures in England & Wales	Defra, Fish IIB, Room 308, Nobel House, 17 Smith Square, London, SW1P 3JR., www.defra.gov.uk
	Scottish Executive Environment & Rural Affairs Department (SEERAD) has responsibility for the administration of WCA & ILFA (Scotland) legislation in Scotland	SEERAD, Pentland House, 47 Robbs Loan, Edinburgh, Scotland, EH14 1TW, www.scotland.gov.uk
	The National Assembly for Wales Agriculture Department (NAWAD) has responsibility for the administration of SFFA, WCA & ILFA legislation in Wales (with CEFAS providing technical support on an agency basis)	NAWAD, Cathays Park, Cardiff, CF10 3NQ, www.wales.gov.uk
	Technical advice to Defra in support of Fish II, relating to introductions of non-native fish species	CEFAS, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, NR33 0HT. www.cefas.co.uk
	Technical advice to Defra in support of Fish II, relating to fish health, movements (incl. imports), ILFA Crayfish order and keeping of non-native species. Enforcement of fish health and ILFA provisions (dealers & fish farms)	CEFAS, Weymouth Laboratory, The Nothe, Barrack Road, Weymouth, Dorset DT4 8UB. www.cefas.co.uk
	Advice and enforcement of WCA and ILFA provisions at fishery sites. Responsible for consenting all movements of freshwater fish (native & non-native) to inland waters under SFFA	Environment Agency, National Disease Laboratory, Bromholme Lane, Brampton, Huntingdon, Cambs. PE18 8NE. www.environment-agency.gov.uk www.environment-agency.wales.gov.uk

Prepared by remedy and control sub-group (please note: this is for illustrative purposes and should not be regarded as an exhaustive list)

	Advises Defra on WCA and ILFA licences	English Nature, Northminster House, Peterborough PE1 1NA. www.english-nature.org.uk
	Advises NAWAD on WCA and ILFA licences	Countryside Council for Wales, Plas Penrhos, Ffordd Penrhos, Bangor, Gwynedd LL57 2LQ. www.ccw.gov.uk
	Technical advice in support of SEERAD	Scottish Natural Heritage, 12 Hope Terrace, Edinburgh EH9 2AS
TERRESTRIAL VERTEBRATES		European Wildlife Division
		Land Use Division
		English Nature
		Scottish Natural Heritage
		CCW
	Technical support for Defra and the statutory conservation agencies	Countryside Management Group, Central Science Laboratory, Sand Hutton, York, YO41 1LZ Joint Nature Conservation Committee, Monkstone House, City Road, Peterborough, PE1 1JY
	Review of Schedule 9	JNCC
	Translocations Policy for the statutory conservation agencies	JNCC, CCW, SNH, EN
FRESHWATER AND RIPARIAN ENVIRONMENTS	Information on control of riparian and aquatic vegetation, including alien invasive species	
		SEPA Corporate Office, Erskine Court, Castle Business Park, STIRLING, FK9 4TR
		English Nature
		Scottish Natural Heritage
		CCW
	Local Control	County and city councils, wildlife trusts, Association of Drainage Authorities, The Ponds Conservation Trust
	Technical support for Defra, Environment Agency and the statutory conservation agencies	Institute of Arable Crops Research, Centre for Aquatic Plant Management, Broadmoor Lane, Sonning, READING, RG4 6TH
	Individual plant species specialists	See Annex 2

- Cannon, R.J.C. (2001). Risk assessment for *Arthurdendyus triangulatus* (the New Zealand Flatworm). *CSL Unpublished Report*.
- Clare, N., Clark, A. & Sanderson, G. (1994). Non-native marine species in British waters: a review and directory. Joint Nature Conservation Committee.
- Claudia, R. & Mackie, G.L. (1994). Practical manual for zebra mussel monitoring and control. CRC Press. 240pp.
- Convention on Biological Diversity (2002) – Decision VI/23 and Guiding Principles. IUCN's "Guidelines for the prevention of biodiversity loss caused by alien invasive species"
- DETR (1998). *Policy appraisal and the Environment: Policy guidance*. HMSO, London.
- DETR (2000). *Guidelines for Environmental Risk Assessment and Management. Revised Departmental Guidance*. HMSO, London.
- EPPO (1997). Pest risk assessment scheme. *EPPO Bulletin*, 27: 281-305.
http://www.eppo.org/QUARANTINE/PRA/prassess_scheme.html
- FAO (2001). Pest risk analysis for quarantine pests. *International Standards for Phytosanitary Measures. Pub. No. 11*. FAO, Rome.
- Fasham, M & Trumper, K. (2001). Review of Non-native Species Legislation and Guidance. Ecoscope.
- Gregory, RD, Noble, DG, Cranswick, PA, Campbell, LH, Rehfisch, M M and Baillie, S R (2001). *The State of the UK's birds 2000*. RSPB, BTO & WWT, Sandy.
- Ingle, R.W. (1986). The Chinese mitten crab *Eriocheir sinensis* H.Milne Edwards- a contentious immigrant. *The London Naturalist*, No. 65: 101-105.
- Preston, C.D., Pearman, D.A. & Dines, T.D. (2002) *The New Atlas of the British and Irish Flora*.
- Ricciardi, A., Whoriskey, F.G. & Rasmussen, J.B. (1995). Predicting the intensity and impact of *Dreissena* infestation on native unionid bivalves from *Dreissena* field density. *Can. J. Fish. Aquat. Sci.* 52, 1449-1461.
- Ricciardi, A., Whoriskey, F.G. & Rasmussen, J.B. (1996). Impact of the *Dreissena* invasion on native unionid bivalves in the upper St. Lawrence River. *Can. J. Fish. Aquat. Sci.* 53, 1434-1444.
- Ricciardi, A., Whoriskey, F.G. & Rasmussen, J.B. (1997). The role of the zebra mussel (*Dreissena polymorpha*) in structuring macro invertebrate communities on hard substrata. *Can. J. Fish. Aquat. Sci.* 54, 2596-2608.

Welch, D., Carss, D.N., Gornall, J., Manchester, S.J., Marquiss, M., Preston, C.D., Telfer, M.G., Arnold, H., & Holbrook, J. (2001). An Audit of Alien Species in Scotland. *Scottish Natural Heritage Review* No. 139.

Williamson, M. (1996) *Biological Invasions*. Chapman and Hall, London.

Williamson, M. (2002). Alien plants in the British Isles. In *Environmental and Economic Costs of Alien Plant, Animal and Microbe Invasions* (ed D. Pimentel). CRC Press

Williamson, M. & Fitter, A. (1996). The characters of successful invaders. *Biological Conservation*, 78: 163-170.

All costings given in this section are approximate, included to illustrate the potential costs of recommendations. Due to the huge potential variation in costs depending on how recommendations are taken forward or variations in what might be required depending on circumstances, it is only possible to give indicative ball-park figures. It should be noted that these estimates are on the basis that the expenditure will not replace existing mechanisms or authorities already covering specific sectors (such as the Plant Health regime and the Import of Live Fish regime) but rather are the additional costs to put equivalent measures in place to protect biodiversity, implementing the recommendations of the Review Group.

Text of recommendation and additional comments	Rough estimate of costs
<p>Key Recommendation 1: The Government should designate or create a single lead co-ordinating organisation to undertake the role of co-ordinating and ensuring consistency of application of non-native species policies across Government.</p> <p>The costs of implementing this recommendation could vary hugely depending on how it is delivered (the report leaves the mechanism of delivery for Government to decide). The most expensive option would be creation of a new agency. Lower cost options would be designation of an existing agency and/or setting up of mechanisms to ensure the necessary co-ordination of functions between existing sectors.</p> <p>A completely new agency would probably involve costs of a minimum of millions of pounds annually for administration and infrastructure plus considerable additional start-up costs. By way of comparison to assist in demonstrating potential costs of creating a new agency to deliver these functions, JNCC's annual budget is in the region of £5 million. English Nature's annual budget is in the region of £60 million. A further comparison with an existing regime for one particular sector, the total cost of administering, supporting and implementing the current Plant Health strategy in the UK is probably in the £10m – £20m band.</p> <p>Designation of an existing organisation, such as JNCC, to undertake this function would take advantage of existing structures and avoid start-up costs, and therefore the costs would be reduced considerably, although an increased budget allocation would be required to pay for the new functions. Other mechanisms to improve co-ordination, such as using a similar model to the Partnership for Action Against Wildlife Crime, may be devised to reduce costs yet further, although this would need to be balanced with effective delivery and implementation of policies.</p> <p>There is therefore a potentially huge variation in cost depending on the method of delivery. Clearly the more expensive options are likely to provide significantly better delivery of policy objectives than lower cost options. The lowest cost option would simply provide for a small number of extra staff within government departments and the nature conservation agencies to provide capacity to take forward the package of recommendations. This would not allow such effective progress as the other options and is seen as the minimum required to make any meaningful progress on the package of recommendations.</p> <p>It should be noted that devolution constrains the method of implementation.</p>	<p>It is important to note that costs of delivery of a number of the other recommendations are considered to be included within this estimate.</p> <p>High cost option Create new agency to undertake functions – approx £5 million pa</p> <p>Mid cost option Designation of existing agency to undertake extra functions – approx £1 million pa</p> <p>Low cost option Small number of extra staff within government departments and conservation agencies to increase capacity – approx £300,000 pa.</p>

Text of recommendation and additional comments	Rough estimate of costs
<p>Key Recommendation 2: Develop comprehensive Risk Assessment procedures to use in assessing the risks posed by non-native species and identifying and prioritising areas for other prevention action.</p> <p>This needs to consider costs for designing a risk assessment procedure, estimated here, and also ongoing annual operating costs for implementation of such a procedure. The annual cost of operating the risk assessment system are considered to be included within the estimates for Key Recommendation 1. This would include the costs of related sub-recommendations (e.g. development of lists based on category of threat and analysis of introduction pathways). Clearly the capacity of the system would depend on whether a high, mid or low cost option was adopted.</p>	<p>Designing a risk assessment and management procedure could cost approx £50,000 to £200,000.</p> <p>The estimate for annual expenditure on operating the system is included within the costs for Key recommendation 1.</p> <p>An estimate for initial work on attributes of non-native species is £50,000 to £100,000.</p>
<p>Key Recommendation 3: Develop codes of conduct to help prevent introductions for all relevant sectors in a participative fashion involving all relevant stakeholders.</p> <p>It is difficult to estimate the cost of this element which would be a significant new policy work stream. Clearly the time spent on this work will depend on the staff time available. Costs can be considered as part of the costs of co-ordinating policies outlined under Key Recommendation 1. Higher cost options will result in the work being taken forward much more quickly.</p>	<p>No extra costs as a result of this recommendation. Costs are covered under Key recommendation 1.</p>
<p>Key Recommendation 4: Develop a targeted education and awareness strategy involving all relevant sectors.</p> <p>A comprehensive targeted education and awareness strategy, covering the issues set out in the sub-recommendations, could be expected to cost in the region of £200,000 pa, perhaps falling in subsequent years once material had been developed.</p>	<p>Approx £200,000 pa</p>
<p>Key Recommendation 5: Revise and update existing legislation to improve handling of invasive non-native species issues.</p> <p>This will remain a function for government departments, including the devolved administrations. There would be resource implications which would have to be met by those departments although at this stage it is impossible to quantify them.</p>	<p>Costs to government departments, but impossible to quantify at this stage.</p>
<p>Key Recommendation 6: Establish adequate monitoring and surveillance arrangements for non-native species in Great Britain.</p> <p>Using the existing organisations who co-ordinate volunteers to gather biological records, and using the NBN partnership as the established mean of bringing these together, would result in an efficient system that makes best use of experienced recorders and the data that have already been gathered by recording schemes and specialist societies. The recording of non-natives, particularly those that are rapidly changing their range, is well-suited to Internet collection of records for quick turnaround and feedback. This type of recording is already being adopted by BTO for the Migration Watch scheme, and it could be used elsewhere with suitable support and investment.</p> <p>It is estimated that it would be possible to put in place a strong module for recording non-native species using NBN and existing organisations at costs of approx £100k pa for plants and £100k pa for animals. So, for a total of £200k pa there would be GB recording, plus funds any species where more detailed data are needed (which might be another 5-10 species at an average of, say, £30k pa each). This assumes using existing mechanisms and processes to gather the data wherever possible, rather than develop new ones.</p>	<p>Total estimated costs £230k pa (£100k monitoring for animals, £100k monitoring for plants and £30k for more detailed studies of particular priority species).</p>

Text of recommendation and additional comments	Rough estimate of costs
<p>Key Recommendation 7: Policies should be established with respect to management and control of invasive non-native species currently present or newly arrived in the wild, and operational capacity be developed to implement these policies.</p> <p>There are a number of separate elements to this recommendation. Some elements such as sub-recommendation 7.1 (developing a structured approach to assess the impact and management of individual invasive non-native species be developed) and sub-recommendation 7.6 (developing web based methods of information transfer and sharing) can be considered as part of the cost of Key Recommendation 1, whilst other elements are considered individually here.</p> <p>One of the most important, and hardest to estimate, is the cost of sub-recommendation 7.3, specifically in respect of developing operational capacity to undertake control of invasive non-native species, especially when newly discovered. It is very difficult to estimate costs for this recommendation. Costs of nominating agencies and developing management plans can be considered to fall within the co-ordinating function and covered by the costs for Key recommendation 1. However, costs of developing capacity to undertake control/management work are not possible to estimate ("how long is a piece of string?", the costs are potentially almost unlimited). A number of organisations already have some existing capacity but on an ad hoc basis. Clearly it will not be possible to eradicate or control all invasive non-native species, especially those which have been present for many years, but it is important to have a contingency capability to eradicate newly discovered introductions.</p>	<p>Costs of developing further operational capacity to undertake control, especially of newly discovered introductions, are very difficult to estimate but will be considerable given that individual management projects can cost over £1million.</p> <p>Strategic funding to support the development of novel control techniques for invasive non-native species is not possible to estimate accurately but potentially over £100,000 pa.</p> <p>Research into the restoration of habitats or communities following the removal of invasive non-native species might typically cost £100,000 per project.</p>
<p>Key recommendation 8: Stakeholders should be fully consulted and engaged in development of invasive non-native species policies and action through a mechanism such as a consultative forum.</p>	<p>No extra costs as a result of this recommendation. Costs are covered under Key recommendation 1.</p>