Non-Native Organism Risk Assessment Scheme:  
Trialling and Peer Review  
(Scottish Executive reference: FF/05/22)

For:  
Scottish Executive  
Environment and Rural Affairs Dep.

EDINBURGH

Olaf Booy BSc (Hons)  
Vicky White BSc (Hons)  
Max Wade BSc (Hons), PhD, FIEEM

December 2006

© RPS  
Willow Mere House  
Compass Point Business Park  
Stocks Bridge Way  
St Ives  
Cambridgeshire  
PE27 5JL

Telephone: +44 (0) 1480 466335  
Fax: +44 (0) 1480 466911  
E-mail: rp SCM@rp SGROUP.com  
www.rpsgroup.com  
www.ecoscope.co.uk
Notice to Interested Parties

To achieve the study objectives stated in this report, we were required to base our conclusions on the best information available during the period of the investigation and within the limits prescribed by our client in the agreement.

No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information. Thus, we cannot guarantee that the investigations completely defined the degree or extent of e.g. species abundances or habitat management efficacy described in the report.

Document Information

<table>
<thead>
<tr>
<th>Report title:</th>
<th>NNRA Trialling and Peer Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client:</td>
<td>Scottish Executive</td>
</tr>
<tr>
<td>Document ref:</td>
<td>JPP1216-R-002a</td>
</tr>
<tr>
<td>Author(s):</td>
<td>Olaf Booy, Vicky White, Max Wade</td>
</tr>
<tr>
<td>Report date:</td>
<td>December 2006</td>
</tr>
</tbody>
</table>

Checked by: {Name} {Signature} {Date}

Authorised by: {Name} {Signature} {Date}
CONTENTS

0 EXECUTIVE SUMMARY .....................................................................................3

1 INTRODUCTION .................................................................................................7
   1.1 Background and development of NNRA .....................................................7
   1.2 Aim and objectives of the NNRA scheme ..................................................7
   1.3 Aim and objectives of the trialling project and peer review .....................8
   1.4 Scope of the trialling and peer review project ...........................................9

2 METHODS ...........................................................................................................10
   2.1 Commissioning and co-ordinating risk assessments .............................10
   2.2 Peer review of the NNRA scheme .............................................................14
   2.3 The practicalities and problems of using the NNRA from the point of
       view of the target risk assessor .............................................................................15

3 RESULTS .............................................................................................................16
   3.1 Outcomes of risk assessments .................................................................16
   3.2 Outcomes of three peer reviews of the NNRA scheme ..........................18
   3.3 The practicalities and problems of using the NNRA from the point of
       view of the target risk assessor. ............................................................................20
   3.4 The practicalities and problems of using the NNRA from the point of
       view of a co-ordinating body................................................................................29

4 DISCUSSION ......................................................................................................33
   4.1 Overall impression ....................................................................................33
   4.2 Practicalities of using and running the scheme ........................................34
   4.3 Assessment of the scoring system ..............................................................41
   4.4 Content and Scope ....................................................................................44

5 CONCLUSIONS.................................................................................................49

6 REFERENCES ......................................................................................................49

7 APPENDICES ......................................................................................................50
TABLES
Table 1. Target distribution of organisation types
Table 2. List of organism risk assessments
Table 3. List of pathway risk assessments
Table 4. Comparison of risk ratings for 23 organism risk assessments
Table 5. Anticipated and actual time taken to complete risk assessments
Table 6. Sources of assessors used in the project

FIGURES
Figure 1. Risk assessor response to the question “the risk assessment was easy to use”
Figure 2. Risk assessor response to ease of use questions
Figure 3. Risk assessor response to value of output questions
Figure 4. Risk assessor response to the question “the risk assessment appropriately identified the risks of the subject non-native species”
Figure 5. Questions regarding risk assessor background
Figure 6. Organisation chart showing suggested working stages in the NNRA development

BOXES
Box 1. Recommendations arising from the project with respect to the further development of NNRA
0 EXECUTIVE SUMMARY

Background, aims and objectives

The Defra Review of Non-Native Species Policy of 2003 made a key recommendation to develop a standard assessment that could be carried out for non-native organisms, for pathways of introduction, for receptors potentially at risk of harm from non-native organisms, and to assess the likelihood of success of management actions. The UK Non Native Organism Risk Assessment scheme (NNRA) was produced as a response, based on a scheme developed for pest/plant health risk assessment by the European and Mediterranean Plant Protection Organisation (EPPO). This project reports on the trialling and peer review of the NNRA, the aim of the project being to provide an overall assessment of the value of the NNRA scheme.

The objectives of the project were to:

1) provide complete risk assessments for 26 species and four pathways;
2) provide three peer reviews of the NNRA scheme;
3) assess the practicalities and problems of using the NNRA from the point of view of the target risk assessor;
4) assess the practicalities and problems of using the NNRA from the point of view of a co-ordinating body;
5) assess the proposed scoring system of the NNRA for the categorisation of responses and the summary of results for risk assessment;
6) identify any other issues that would help the development of the NNRA as a working tool for risk assessment in the UK, and
7) make recommendations on the NNRA and its implementation.

The project provides an assessment of the NNRA scheme in relation to the modules concerning the risk assessment of non-native organisms and pathways of introduction in relation to organisms that could be released in the UK and its overseas territories. The 26 organisms identified to be included in the trialling project were already present in the risk assessment areas (21 in the UK and five in Overseas Territories), a large proportion of which were well established and widespread. Four pathways were identified.

Commissioning and co-ordinating risk assessments

Risk assessors were sought from a range of organisations to complete the trialling of risk assessments of 26 species and four pathways. Four of these species and one pathway could not be assessed as appropriate experts to complete these could not be found in the time allocated for this work. Assessors were asked to complete the risk assessment of an organism or pathway based on the user manual and Excel spreadsheet developed as the basis of the NNRA scheme, with support being provided by the project coordinators.

Completed risk assessments were subjected to a non-technical appraisal to attempt to identify any misinterpretations or weaknesses in the response and identify any problems the risk assessor had with the electronic format and the structure of the questions.
Peer review of the NNRA scheme.

Three peer reviewers (and a fourth peer review contact who volunteered comments via email) were chosen from a list provided by the Scottish Executive. Peer reviewers were asked to:

- consider and report on particular strengths of the NNRA;
- consider and report on any gaps or weaknesses of the scheme;
- suggest any potential improvements to the scheme, and
- comment on comparisons between this scheme and any others with which they may be familiar.

Completed reports were reviewed by members of the project co-ordinating team and key points of each review were evaluated and summarised.

The practicalities and problems of using the NNRA

A questionnaire was used to identify the practicalities and problems of using the NNRA from the viewpoint of each risk assessor, covering overall impression, background of the risk assessor, ease of use, value of the output and any recommendations for improvement.

The completed risk assessments, questionnaires and peer reviews were evaluated to provide:

- an assessment of the proposed scoring system of the NNRA, and
- identification of issues that would help the development of the NNRA as a working tool for risk assessment in the UK, and recommendations.

Results

Risk assessments were received for 22 organisms and three pathways with associated comments and completed questionnaire (19 were returned). Three peer reviews of the NNRA scheme were completed and comments were received from a fourth expert.

Conclusions and recommendations

The NNRA scheme was praised for its ambitious aim to provide a generic risk assessment for all non-native organisms and pathways in the UK. A significant amount of work has been done to develop the scheme and all of the peer reviewers and the majority of risk assessors identified that it includes the fundamental components required for appropriate risk assessment. A considerable amount more work is still required, and the need for considerable improvement in the clarity and simplicity of the scheme was identified.

The main areas that need developing and improving are listed below along with a number of recommendations that were drawn from the project.
Practicalities of using and running the scheme

1. Clearly define the purpose(s) of undertaking the risk assessment.
2. Develop a bespoke, user-friendly manual including a stepwise guide to completing the assessment.
3. Provide model risk assessment examples as guidance for risk assessors. These should be thorough, clearly understandable and without mistakes and incorporated into the user manual.
4. Incorporate comments into the body of text rather than as hidden comments.
5. Ensure that comments do not fundamentally change the meaning of questions.
6. Hide the currently visible calculations that do not concern risk assessors.
7. Remove or reassess the use of the Pheloung and FISK spreadsheets.
8. Use more accessible language throughout the scheme including spreadsheets and the user manual. Where used, any terms that could lead to misunderstanding should be clearly defined and a full glossary provided.
9. Explore the potential for assessor bias in NNRA and determine whether measures need to be taken to eliminate any such effect and how.
10. Improve existing format (Excel spreadsheet), one feature of which could be looping (e.g. for additional pathways on organisms assessments). End users should be consulted on the development of any electronic toolkit.

Assessment of the scoring system

11. Undertake calibration of the categorised answers. Develop similar tables to those provided in Module 4 (Tables 1 and 2) for all relevant questions in all risk assessment modules.
12. Carry out further work to introduce a more representative weighting system without the need for repetition of questions.
13. Clearly define high, medium and low with respect to risk organisms in relation to summary scores.

Content and scope

14. Consider the addition of question subsets to deal with major taxonomic groups (e.g. mammals, invertebrates and plants).
15. Give further consideration to incorporating climate mapping or of climate data that would be required.
16. Acknowledge the immaturity and lack of pedigree in the NNRA scheme in relation to the amount of additional development the scheme will need. The development of the EPPO scheme could be valuable in appraising the scale and nature of development that is likely.
17. Accompany the launching of the NNRA by a programme of training and education to provide personnel competent and trained in its implementation and use. The training and education underpinning the EPPO would be a useful model for what is required.
18. More fully integrate the assessment of non-native organisms established and widespread in the risk assessment area into the NNRA scheme.
19. Make the scope of the NNRA simpler by reducing it to exclude overseas territories.
20. Make the scope of the NNRA simpler by reducing it to exclude receptor assessment and policy considerations.
1 INTRODUCTION

1.1 Background and development of NNRA

The Defra Review of Non-Native Species Policy (Defra 2003) made a key recommendation to “develop comprehensive, accepted risk assessment procedures to assess the risks posed by non-native species.” The procedures were recommended to provide a standard assessment that could be carried out for non-native organisms, for pathways of introduction, for receptors potentially at risk of harm from non-native organisms, and to assess the likelihood of success of management actions.

In response to this recommendation Defra commissioned the UK Non Native Organism Risk Assessment scheme (NNRA) which was developed by a consortium of CABI Bioscience (CABI), Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Centre for Ecology and Hydrology (CEH), Central Science Laboratory (CSL), Imperial College London and the University of Greenwich under Defra Contract CR0293 in February 2005 (Baker et al. 2005).

The NNRA is based on a scheme developed for pest/plant health risk assessment by the European and Mediterranean Plant Protection Organisation (EPPO 1997). The EPPO scheme closely follows the International Standard for Phytosanitary Measures (ISPM 11) on pest risk analysis produced by the International Plant Prevention Convention (IPPC) (FAO 2003). EPPO itself reported that with minor adaptations the scheme could be made suitable for the assessment of non-native organisms (Baker et al. 2005). Its use as a basis for the NNRA followed a recommendation in the Defra Review (Defra 2003) and previous adaptations of the EPPO scheme for groups of animals (e.g. for invasive freshwater fish (Copp et al. 2005)).

1.2 Aim and objectives of the NNRA scheme

The aim of the NNRA as set out by the original consortium is to provide “a procedure for the assessment of the risks posed by any non-native organism to species, habitats or ecosystems in all or part of the UK. Risk assessments of the pathways that may carry non-native organisms and of receptors that may be vulnerable to non-native invasion can also be carried out by this scheme. In addition to the assessment of specific cases, it can also be used to help inform policies on invasive non-native species” (Baker et al. 2005).

The Defra Review (2003) adds more specific objectives with regard to organisms, pathways, receptors and management actions, as set out below.

Non-native organisms

Assessments can be carried out to determine the risks posed by particular non-native organisms in relation to the safety of intentional introductions, e.g. for the purposes of biocontrol, and the likelihood of unintentional introductions occurring and causing significant harm to organisms, habitats and ecosystems in an area.

Pathways

Risk assessments can be carried out on pathways through which non-native organisms can enter an area. This may allow the risk assessor to distinguish those that represent the greatest risk.
Receptors

Risk assessments for receptors such as ecosystems and habitats, commercial interests, or human health, can be undertaken by determining the likelihood of invasive non-native organisms adversely affecting a given receptor. Of particular interest is the threat posed by invasive non-native organisms to native species of wildlife, groups of species, habitats or ecosystems within an area.

Management actions

For many non-native organisms, a risk assessment will conclude that the risk posed is negligible and no action will be required. Where the risk is determined to be significant, risk management options need to be considered and the identification of these options will be facilitated by a risk assessment considered separately or in combination.

In addition, the Defra review identifies that risk assessments should be fit for purpose, responding to the requirements of risk managers, communicators and policy makers while taking into account the time, information and resources available, the complexity of the situation and the prospect of a dispute arising (Defra 2003).

A key point in the Defra Review is that the results of risk assessments may be used to develop lists of non-native organisms which are known or are likely to have harmful consequences. One suggested outcome is a system where non-native organisms are grouped into high, medium and low risk categories. Organisms on the ‘High Risk List’ would be those that are demonstrably invasive now or could be in the future and hence would be considered for legislative instruments, codes of conduct, best practice guidelines and/or other implementation tools as well as for regulation on import and sale. The ‘Medium Risk List’ would comprise organisms for which further work would be required to demonstrate whether there is a significant risk of becoming invasive and causing problems. ‘Low Risk List’ organisms would be those considered unlikely to cause problems.

1.3 Aim and objectives of the trialling project and peer review

The aim of the trialling and peer review project, i.e. the broad outcome that is required, is to provide an overall assessment of the value of the NNRA scheme.

The breadth of this overall assessment is defined by the objectives of the NNRA trialling and peer review project, i.e. the specific deliverables that can be clearly identified and will be provided by this project. These are to:

1) provide complete risk assessments for 26 species and four pathways;
2) provide three peer reviews of the NNRA scheme;
3) assess the practicalities and problems of using the NNRA from the point of view of the target risk assessor. This objective was considered in four parts:
   i. overall impression;
   ii. background of the risk assessors in their approach to using the scheme;
   iii. ease of use;
   iv. value of output;
4) assess the practicalities and problems of using the NNRA from the point of view of a
co-ordinating body;

5) assess the proposed scoring system of the NNRA for the categorisation of
responses and the summary of results for risk assessment. This objective was
considered in two parts:
   i. the practical implementation of the scoring system,
   ii. determining if the scoring system is fit for purpose;

6) identify any other issues that would help the development of the NNRA as a
working tool for risk assessment in the UK, and

7) make recommendations on the NNRA and its implementation.

This report describes the methodology used to collect the information needed to meet
these objectives and provide feedback on how successfully this was achieved. The results of
objectives 1-4 are presented in the Results section, followed by a discussion of the outcomes
for all seven objectives leading to consideration of fundamental issues identified and a series
of key recommendations.

1.4 Scope of the trialling and peer review project

The trialling and peer review project reported here provides an assessment of the NNRA
scheme in relation to the modules concerning the risk assessment of non-native organisms
and pathways of introduction. This is supported by the completion of test risk assessments
for organisms and pathways, and three reviews of the scheme undertaken by independent
peer reviewers. The trialling and peer review project did not focus on other elements of
the scheme relating to additional modules (e.g. receptor assessment and risk management).
Where peer reviewers provided information regarding these additional modules, this has
been included in Appendix 2.

The NNRA scheme was developed to encompass organisms that could be released in Great
Britain and its overseas territories (OTs). The trialling and peer review project reflected
this by assessing organisms relevant to Great Britain (i.e. Scotland, Wales and England) and
individual islands or groups of islands within UK overseas territories. The trialling and peer
review project was not designed to assess how capable the scheme was at assessing regions
or smaller parts of these areas (e.g. individual counties or regions); however the NNRA was
designed to include this capability.

Pest risk analysis schemes, such as EPPO, often focus on organisms that are not present or
established in the risk assessment area, but have the potential to enter and cause damage.
The scope of the NNRA scheme includes these organisms, but also makes provision for
organisms that are already present and already established in the risk assessment area.
Sixteen of the twenty-six organisms assessed in the trialling and peer review project were
known to be established, and in some cases widespread, in their risk assessment area.
2 METHODS

2.1 Commissioning and co-ordinating risk assessments

Risk assessors were sought from a range of different organisations to complete the risk assessments. This was requested by the Scottish Executive in order to assess how individuals with a variety of backgrounds approached the scheme. The desired distribution of organisation categories compared to the actual distribution achieved is given in Table 1.

Table 1. Target distribution of organisation types

<table>
<thead>
<tr>
<th>Organisation type</th>
<th>Number of species and pathways</th>
<th>Number of species and pathways</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target</td>
<td>Actual</td>
</tr>
<tr>
<td>NGOs (e.g. RSPB, Plantlife, WWT and BSBI)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Public institutes (e.g. RBG Edinburgh and RBG Kew)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Universities</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Environmental protection agencies (e.g. SEPA and Environment Agency)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Statutory conservation agencies, public bodies and institutes</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>(e.g. SNH, CCW, NE (formerly EN) and JNCC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overseas Territory environment specialists</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Relevant trade/industry bodies (e.g. Ornamental Aquatic Trade Association and Horticultural Trades Association)</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>None (risk assessment not complete)</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Risk assessors were selected using the following criteria:

- together they represented a wide range of organisation types (as listed above);
- they had not previously undertaken, been consulted on, or read risk assessments already undertaken and used in the development of the NNRA scheme;
- they had appropriate knowledge of the organism within the risk assessment area,
- they were able to complete the assessment for a set budget and within a limited timeframe.

The co-ordinators initially carried out a brainstorming exercise to find contacts and organisations capable of carrying out the risk assessments. Additional contacts were made through referral from existing contacts or by Internet and telephone research. In some instances the Scottish Executive suggested contacts for difficult organisms.
Twenty-three species and three pathways were trialled. These are listed in Tables 2 and 3 respectively. The remaining four species and one pathway could not be assessed as appropriate experts to complete these could not be found in the time available for the project.

Table 2. List of organism risk assessments

<table>
<thead>
<tr>
<th>Species</th>
<th>Type</th>
<th>Risk Assessment Area</th>
<th>Organisation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Heterosiphonia japonica</em></td>
<td>Red algae</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Public Institute</td>
</tr>
<tr>
<td><em>Sargassum muticum</em> (Wireweed)</td>
<td>Marine algae</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Public Institute</td>
</tr>
<tr>
<td><em>Crassula helmsii</em> (Australian Swamp Stonecrop)</td>
<td>Aquatic plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Trade / Industry</td>
</tr>
<tr>
<td><em>Eichhornia crassipes</em> (Water Hyacinth)</td>
<td>Aquatic plant</td>
<td>Caribbean Group (Anguilla, Turks and Caicos, Montserrat, Cayman Islands, British Virgin Islands)</td>
<td>Overseas Expert</td>
</tr>
<tr>
<td><em>Lugwigia species</em> (Water Primrose)</td>
<td>Aquatic plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Trade / Industry</td>
</tr>
<tr>
<td><em>Fallopia japonica</em> (Japanese Knotweed)</td>
<td>Terrestrial plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>EPA</td>
</tr>
<tr>
<td><em>Cotoneaster species</em></td>
<td>Terrestrial plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Statutory Conservation Agency</td>
</tr>
<tr>
<td><em>Impatiens glandulifera</em> (Himalayan Balsam)</td>
<td>Terrestrial plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>University</td>
</tr>
<tr>
<td><em>Miscanthus sinensis</em> (Elephant Grass)</td>
<td>Terrestrial plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Public Institute</td>
</tr>
<tr>
<td><em>Buddleja davidii</em> (Buddleia)</td>
<td>Terrestrial plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Trade / Industry</td>
</tr>
<tr>
<td><em>Lysichiton americanum</em> (Skunk Cabbage)</td>
<td>Deciduous perennial bog plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>Statutory Conservation Agency</td>
</tr>
<tr>
<td><em>Allium triquetum</em> (Three Cornered Leek)</td>
<td>Terrestrial plant</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>NGO</td>
</tr>
<tr>
<td>Species</td>
<td>Type</td>
<td>Risk Assessment Area</td>
<td>Organisation Type</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>*Gyrodactylus salaris</td>
<td>Salmon parasite</td>
<td>Great Britain (Scotland, England and Wales)</td>
<td>None</td>
</tr>
<tr>
<td>Hemimysis anomala</td>
<td>Mysid crustacean</td>
<td>Great Britain</td>
<td>Trade / Industry</td>
</tr>
<tr>
<td>Eriocheir sinensis (Chinese Mitten Crab)</td>
<td>Decapod crustacean</td>
<td>Great Britain</td>
<td>Public Institute</td>
</tr>
<tr>
<td>Achatina fulica (Giant African Snail)</td>
<td>Mollusc</td>
<td>Caribbean Group (Anguilla, Turks and Caicos, Montserrat, Cayman Islands, British Virgin Islands)</td>
<td>Overseas Expert</td>
</tr>
<tr>
<td>*Aethina tumida (Small Hive Beetle)</td>
<td>Insect</td>
<td>Great Britain</td>
<td>None</td>
</tr>
<tr>
<td>Solenopsis invicta (Red Imported Fire Ant)</td>
<td>Insect</td>
<td>Anguilla and/or Montserrat</td>
<td>Overseas Expert</td>
</tr>
<tr>
<td>Harmonia axyridis (Harlequin Ladybird)</td>
<td>Insect</td>
<td>Great Britain</td>
<td>University</td>
</tr>
<tr>
<td>*Bufo marinus (Cane Toad)</td>
<td>Amphibian</td>
<td>Turks and Caicos</td>
<td>None</td>
</tr>
<tr>
<td>Carassius auratus (Goldfish)</td>
<td>Fish</td>
<td>Great Britain</td>
<td>University</td>
</tr>
<tr>
<td>Boiga irregularis (Brown Tree Snake)</td>
<td>Reptile</td>
<td>British Indian Ocean Territories</td>
<td>Overseas Expert</td>
</tr>
<tr>
<td>Bubo bubo (Eagle Owl)</td>
<td>Bird</td>
<td>Great Britain</td>
<td>NGO</td>
</tr>
<tr>
<td>Tamias species (Chipmunk)</td>
<td>Mammal</td>
<td>Great Britain</td>
<td>Trade / Industry</td>
</tr>
<tr>
<td>Muntiacus reevesi (Chinese Muntjac)</td>
<td>Mammal</td>
<td>Great Britain</td>
<td>NGO</td>
</tr>
<tr>
<td>Amblonyx cinereus (Oriental Small-clawed Otter)</td>
<td>Mammal</td>
<td>Great Britain</td>
<td>NGO</td>
</tr>
</tbody>
</table>

* Organisms for which risk assessments were not be completed
Table 3. List of pathway risk assessments

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Risk Assessment Area</th>
<th>Organisation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeroplane-assisted transfer of non-native insects via air containers to St. Helena (through the proposed St. Helena runway)</td>
<td>St. Helena</td>
<td>NGO</td>
</tr>
<tr>
<td>Human-assisted introduction of non-native aquatic plants into and between water bodies in Great Britain</td>
<td>Great Britain</td>
<td>Trade/Industry</td>
</tr>
<tr>
<td>The human-assisted introduction of non-native fish species into Great Britain and between water bodies</td>
<td>Great Britain</td>
<td>EPA</td>
</tr>
<tr>
<td>* Bird escapes from zoos and wildlife parks</td>
<td>Great Britain</td>
<td>None</td>
</tr>
</tbody>
</table>

* Pathways for which risk assessments were not completed

All potential risk assessors were initially telephoned, or if based abroad emailed, to gauge their suitability and willingness to complete the risk assessments for an identified organism or pathway. Potential risk assessors were then provided with a letter detailing the aims and background of the project, the user manual for the scheme, the main NNRA template and two completed examples of the main NNRA template. The scheme was supplied to assessors in the same form that it was received by the coordinators. No changes to format or content were made before distribution.

Potential assessors were asked to consider if they were able to complete the assessment in the form provided and, if so, to provide an indication of the length of time and cost for their work. Once agreed, a contract for completion was formed between the contractor and RPS.

Throughout the period risk assessors were undertaking their assessments, the co-ordinators were available to receive questions and provide advice. This ranged from answering email enquiries to visiting the risk assessors if necessary, however the majority of support was provided through telephone communication. Regular communication was maintained with risk assessors throughout the assessment period to ensure they were not experiencing difficulties. This also served to encourage prompt completion. A spreadsheet of risk assessors was maintained by the co-ordinators to keep track of their progress and record comments and feedback.

Upon return of their completed risk assessment, a technical appraisal was undertaken by a member of RPS staff to ensure answers were entered correctly and were supported appropriately. Where significant issues or inconsistencies were found, assessments were returned to participants with comments for clarification or modification. However, the co-ordinators resisted making significant changes as the purpose of the trialling project was to reflect the value of the scheme, which was considered to include any difficulties experienced or errors made by the assessors.
The co-ordinators did not have expert knowledge of all of the organisms being assessed and as such did not provide a technical evaluation to assess the accuracy of each of the risk assessors’ response for their organism. However, a non-technical evaluation was undertaken of each to attempt to identify any misinterpretation or weakness in the response. The risk assessment scheme required the assessor to provide both a response and a comment for each question. The co-ordinators compared each response to the associated comments to establish whether the comment was relevant to, and supported the given response. In some cases this evaluation process identified that comments were not relevant to the given response, and occasionally comments revealed that the risk assessor had misunderstood the question asked.

The checking process also identified the problems the risk assessor had with the electronic format (e.g. the appropriate use of pull down menus and inputting information into the correct cells) and the structure of the questions (e.g. following the instructions to skip certain questions or sections if instructed to do so).

When received and checked, final risk assessments were made anonymous. In some cases final assessment were edited to ensure formatting complied with the requirements of the Excel spreadsheet.

2.2 Peer review of the NNRA scheme.

The Scottish Executive provided the contact details of potential peer reviewers with appropriate experience in similar non-native risk assessment schemes, all of whom were based in Australia or New Zealand. All of the recommended reviewers were contacted via email. As with those trialling the scheme, peer reviewers were asked to supply the co-ordinators with an estimate of the time it would take to complete and a quote for the costs involved. Three peer reviewers were chosen from the respondents and contractual arrangements confirmed. A fourth peer review contact volunteered comments via email but did not undertake a full review.

Peer reviewers were provided with guidance notes and were asked to:

- consider and report on particular strengths;
- consider and report on any gaps or weaknesses of the scheme;
- suggest any potential improvements to the scheme, and
- comment on comparisons between this scheme and any others with which they might be familiar.

All documents relevant to the scheme were provided to peer reviewers including the main risk assessment and its various modules, examples provided by the original consortium of completed risk assessments and the user manual. The user manual was provided in Word so that annotated comments could be made by the peer reviewers if desired. In addition, examples of risk assessments completed during the trialling scheme were made available to assist peer reviewers in their understanding of the scheme in practice.

Completed peer reviews were assessed by members of the co-ordinating team. The key points of each review were evaluated and summarised. Key differences and similarities in peer reviewer’s views were noted. The identities of the peer reviewers (and additional
fourth reviewer) have been kept anonymous to ensure the objective analysis of the reports once submitted to the Scottish Executive.

2.3 The practicalities and problems of using the NNRA from the point of view of the target risk assessor

The practicalities and problems of using the NNRA from the viewpoint of the risk assessor were established for the most part by a separate questionnaire (Appendix 3). The areas covered in the questionnaire included overall impression, background of the risk assessor, ease of use, value of the output and any recommendations for improvement (the questionnaire was not completed by the two assessors on the co-ordinator team).

Assessors were encouraged to use the questionnaire to comment on the value of the output of their assessment including whether it met their expectations. Upon completion, information from the questionnaires was collated into a spreadsheet to facilitate analysis of data. A set of graphs using questionnaire data was constructed where answers fell into discrete groups to show each category of information in a more user-friendly way (Figures 1-5).

In addition, any questions, queries or concerns that were raised by risk assessors during the trialling project were noted.

The completed risk assessments, questionnaires and peer reviews were used to:

- assess the proposed scoring system of the NNRA for the categorisation of responses and the summary of results for risk assessment, and
- identify issues that would help the development of the NNRA as a working tool for risk assessment in the UK and recommendations.
3 RESULTS

3.1 Outcomes of risk assessments

In total 23 species and three pathways were trialled. Experts could not be found to complete assessments for Cane Toad, *Gyrodactylus salaris*, Small Hive Beetle and the pathway entitled ‘Bird escapes from Zoos and Wildlife Parks pathway’ within the time permitted for this contract. A review of the difficulties in obtaining these assessments is provided in Section 3.4.

The risk assessments were completed by 23 contacts made by the coordinating team from 21 different organisations. Experts from the coordinating team completed three risk assessments, with a fourth completed with the assistance of a coordinator. The range and number of organisation types is summarised in Table 1. Table 2 provides a breakdown of the species assessed and organisations used to complete assessments. Table 3 provides a similar breakdown for pathways.

The NNRA provides ‘high’, ‘medium’ and ‘low’ risk scores for each assessment. Three sets of scores were produced for each organism: assessors’ risk rating, calculated risk rating and conditional probability (Table 4). The assessors’ risk rating was the category chosen by risk assessors when asked to identify their organism as high, medium or low risk. This categorisation was based solely on the view of the assessor without additional clarification. Calculated risk rating was automatically provided by the summarising statistics of the scheme and is the summed total of responses given by the risk assessors. This was then categorised into high, medium and low risk ratings based on whether the scores lay in the top, middle or lower third of the possible range. Conditional probability rating was calculated by assigning a probability score to each answer and assigning an overall rating based on whether the final probability lay in the top, middle or lower third of the possible range (i.e. >0.666, 0.334 – 0.666, <0.3334).
Table 4. Comparison of risk ratings for 23 organism risk assessments

<table>
<thead>
<tr>
<th>Common Names</th>
<th>UK or OT</th>
<th>Assessor's Risk Rating</th>
<th>Calculated Risk Rating</th>
<th>Conditional Prob. Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese Mitten Crab</td>
<td>UK</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Australian Swamp Stonecrop</td>
<td>UK</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Giant African Snail</td>
<td>OT</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Harlequin Ladybird</td>
<td>UK</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Water Hyacinth</td>
<td>OT</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Japanese Knotweed</td>
<td>UK</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Heterosiphonia japonica</td>
<td>UK</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Buddleia</td>
<td>UK</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Water Primrose</td>
<td>UK</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Cotoneaster species</td>
<td>UK</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Wireweed</td>
<td>UK</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Brown Tree Snake</td>
<td>OT</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Goldfish</td>
<td>UK</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Red Imported Fire Ant</td>
<td>OT</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Three Cornered Leek</td>
<td>UK</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Chipmunk</td>
<td>UK</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Mysid crustacean</td>
<td>UK</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>American Skunk Cabbage</td>
<td>UK</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Himalayan Balsam</td>
<td>UK</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Muntjac Deer</td>
<td>UK</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Elephant Grass</td>
<td>UK</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Oriental Small-clawed Otter</td>
<td>UK</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Eagle Owl</td>
<td>UK</td>
<td>Terminated</td>
<td>Terminated</td>
<td>Terminated</td>
</tr>
</tbody>
</table>
Eagle Owl was terminated during the risk assessment because it was found not to be an invasive non-native according to the risk assessor. This is discussed in section 4.3 (discrepancies between NNRA calculated and risk assessor rating).

A discussion of the findings for Himalayan Balsam, Brown Tree Snake and Three Cornered Leek is also provided in Section 4.3.

3.2 Outcomes of three peer reviews of the NNRA scheme

Three peer reviews were completed of the NNRA scheme plus comments from a fourth expert (Appendix 1). The main outcomes of the reviews were:

Key Strengths

- The impression of the peer reviewers was that the scheme was ambitious but feasible and that the efforts so far should be applauded.
- All of the peer reviewers agreed that the developed scheme was impressive and covers the fundamental components necessary, but that much work still needs to be done to develop it as a robust tool.
- There was general agreement that the scheme is based on other appropriate and well-established schemes.
- Peer reviewers praised the novel inclusion of a scoring system to record uncertainty and the many methods used to summarise the risk assessment results.
- Peer reviewers commended the documentation of evidence supporting each answer.
- Few positive comments were made about the format, structure and language of the scheme. However, one assessor commented that the scheme was logical and relatively easy to use. Another commented that the user manual was helpful and informative.

Key Weaknesses

- All of the peer reviewers reported that the layout and guidance for use of the scheme was confusing.
- All peer reviewers reported that the language and wording of the scheme were often confusing and at times this led to misunderstanding. In particular, they highlighted the confusing use of double negatives, vague unspecified terms and unrecognised definitions.
- Some questions were found to be overly repetitive. Reviewers considered this might have been in order to provide additional weighting to different sections of the risk assessment. However, it was noted that repetition could cause bias in the results and did not follow the intentions of encouraging a rapid risk assessment.
One peer reviewer commented that uniform weighting of each question could lead to the dilution of importance for some questions while over-emphasising the importance of others.

All reviewers highlighted that climate assessment was not given enough attention in the risk assessment.

Peer reviewers found that the boundaries between the five likelihood categories were not clearly defined (except for economic impact) and could therefore be misleading. Clear guidance was recommended to help choose categories for response.

The species assessment is meant to take into account multiple pathways and equally pathway assessments are meant to take into account multiple species. Peer reviewers commented there is no provision for this type of repetition in the spreadsheet provided.

Peer reviewers raised the question as to whether both policy and receptor assessment should be part of the same scheme.

Confusion existed among the peer reviewers over whether the assessment can be used to assess species widespread in the risk assessment area.

One peer reviewer suggested that the wider scheme / policy base needed clarification to provide a better understanding of the purpose of the scheme.

One peer reviewer identified that the process for reviewing assessments with high uncertainty post risk assessment is not clear.

One peer reviewer indicated that Section A might not be robust enough to determine the need for full assessment.

It was considered unclear how the scheme will fit into the broader decision making processes.

Some questions were considered too difficult or impossible to answer due to limits in current knowledge.

Peer reviewers indicated that there was a need to provide clearer definition of the risk assessment area.

One peer reviewer felt there was an inappropriate use made of the Pheloug plant attributes spreadsheet.

Recommendations emerging from the peer reviewers’ reports were collated and these are considered in the discussion.

Where peer reviewers commented on modules other than those focussed on in this project, their comments were collated and are presented in Appendix 2.
3.3 The practicalities and problems of using the NNRA from the point of view of the target risk assessor.

In total, 19 risk assessors completed questionnaires in addition to the risk assessments. The results of these are presented below.

Overall impression - positive comments

Seven risk assessors commented that they found the risk assessment comprehensive with appropriate questions covering the issues relevant to their organism. One assessor pointed out that their organism was not obviously likely to fit into the risk assessment scheme (as a marine algae) but was pleased to find the questions did work quite well.

One assessor commented that they found the scheme provided an unbiased factual account of the risk associated with potentially invasive species. However, another considered that the scheme was almost entirely subjective and recommended more quantitative questions should be posed.

One assessor noted that being able to record uncertainty was useful and allowed flexibility in response.

One assessor noted the scheme had the advantage that it is focussed on Great Britain as a whole rather than a proportion of it (e.g. an individual country or region). This allowed for a more balanced approach to assessing risks.

One risk assessor commented that the provision of completed example risk assessments was very helpful as guidance in completing their own. However, others responded that examples were not complete or not exactly in line with the user manual which led to confusion and ambiguity, and that additional columns that were populated by apparently irrelevant figures (these are used to calculate the risk summaries in other sheets) were confusing.

Overall impression - negative comments

i. Format, structure and language

Eleven risk assessors commented that the scheme as it stands is daunting, not easy to use or confusing. This was linked to both cosmetic and more fundamental issues.

The format of the risk assessment scheme was criticised for being confusing. This was due to the length of the documentation, use of hidden comments, pull down menus and apparently irrelevant sections (such as the Pheloung plant attributes and Fish Invasiveness Screening Kit (FISK) embedded spreadsheets) in the Excel spreadsheet. Many assessors were not familiar enough with Excel to use these elements and understand the format of the assessment. One assessor, who had a detailed knowledge of Excel, commented they felt more basic users would struggle to use the spreadsheet.

Several risk assessors were initially confused by the inclusion of the calculations and statistical analysis sheets in the main spreadsheet. Some spent time trying to work out whether they needed to provide additional input into these or use them in some way. Of
particular concern is that in at least one case an assessor indicated that they changed their responses to some questions in order to affect the outcome of the score summary results.

A separate and much criticised element of the scheme was the language and wording used. Assessors reported that the lack of clarity in the questions made them confusing. Double negatives and ambiguous definitions were highlighted as problem areas.

Three assessors considered a lack of appropriate guidance a problem. This resulted in uncertainty in how to treat the different sections; often assessors did not know what was required for certain answers. Some assessors noted that the user manual did not follow the spreadsheet exactly, which added to their confusion. Nine risk assessors reported that they found the user manual too heavy going to take in properly and many had been put off using it, choosing to be guided solely by the spreadsheet and example assessments.

ii. Providing question subsets for groups of organisms

Six risk assessors reported that they felt the questions asked were not entirely relevant to their organism. Of these six, three also reported that they felt important questions had not been asked about their organism. In some cases this was considered so important as to significantly affect the relevance of the assessment. A general impression among these assessors was that it would be better to have a different set of questions for different groups or organisms (e.g. mammals).

iii. Suitability for already widespread organisms

Two assessors noted that the scheme was more appropriate for organisms that were not yet present in the risk assessment area, rather than for those that were widespread. One noted confusion over whether the source of spread should be considered the organism’s invaded or native range.

iv. Complexity of questions

Three risk assessors reported that to answer many questions required considerably more information than was available based on current research. The embedded economic risk assessment module was highlighted as one that had particularly difficult questions. It could be inferred that this was probably true of other assessors, most of whom were unable to complete this section.

Ease of use

i. Length of time taken to complete assessments

The length of time taken to complete the organism assessments varied widely between assessors (Table 5). The minimum time taken was four hours; although this assessment terminated before reaching Section B of the assessment (i.e. the organism was found not to be a non-native invasive). The minimum time taken to complete the assessment including section B was slightly longer at five hours. The maximum time taken to complete the assessment was 40 hours; the range between minimum and maximum being 35 hours. The mean time taken to complete the species assessment was 19.2 hours.
Risk assessors were asked to anticipate the length of time it would take to complete their assessments prior to undertaking them. On average the anticipated completion time was 15.9 hours. Therefore on average, each assessment took 3.3 hours longer than expected to complete, with a maximum of 17 additional hours for one assessment.

For pathway assessments, the time taken to complete assessments was significantly less, ranging from 2 hours to 2.5 hours.

Whilst the majority of assessors completed the assessment without additional consultation from other experts, six required at least some additional consultation. An average of approximately 2.5 hours of additional input was required from each additional consultant.

Table 5. Anticipated and actual time taken to complete risk assessments

<table>
<thead>
<tr>
<th>Organism / Pathway</th>
<th>Anticipated Number of Hours to Complete</th>
<th>Actual Number of Hours to Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heterosiphonia japonica</strong></td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Wireweed</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Australian Swamp Stonecrop</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Water Hyacinth</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Water Primrose</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Japanese Knotweed</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td><em>Cotoneaster sp.</em></td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Himalayan Balsam</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Elephant Grass</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Buddleia</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Skunk Cabbage</td>
<td>No data</td>
<td>6</td>
</tr>
<tr>
<td>Three Cornered Leek</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Mysid crustacean</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>Chinese Mitten Crab</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Giant African Snail</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>Harlequin Ladybird</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Red Imported Fire Ant</td>
<td>No data</td>
<td>5</td>
</tr>
<tr>
<td>Goldfish</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>
Organism / Pathway | Anticipated Number of Hours to Complete | Actual Number of Hours to Complete
--- | --- | ---
Brown Tree Snake | No data | 23
Eagle Owl | 2 | 4
Chipmunk | 23 | 23
Muntjac Deer | 8 | 14
Oriental Small Clawed Otter | 6 | 6
Aeroplane-assisted transfer of non-native insects via air containers to St Helena (through the proposed St. Helena runway) | No data | No data
Human-assisted introduction of non-native aquatic plants into and between water bodies in Great Britain | 2 | 2
Human-assisted introduction of non-native fish species into Great Britain and between water bodies | 2.5 | 2.5

ii. Overall impression of ease of use (Figure 1)

58% of the organism assessors agreed and an additional 11% strongly agreed with the statement “the risk assessment was easy to use”. 21% responded that they disagreed and an additional 5% strongly disagree. 5% responded that they neither agreed nor disagreed.

Both pathway risk assessors (a co-ordinator completed the third) responded that they disagreed with this statement.

Majority agreement that the scheme was easy to use appears to be in contradiction with the statements made when risk assessors were asked to give their overall impression of the scheme (57% responded that they found the scheme daunting, confusing or difficult to use). Comments indicated that this could be a difference between the overall impression of the whole scheme, and the ease of use of the risk assessment template once risk assessors had overcome initial difficulties.
iii. Electronic format

68% of respondents answered that the electronic format of the risk assessment was easy to use (Figure 2). However, 36% of those included caveats in their response that some sections were difficult to use or confusing. Of the 32% that found the electronic format difficult to use, one assessor responded strongly negatively that the format was difficult and frustrating. Another noted that without a detailed knowledge of Excel, the assessment would have been difficult.

iv. Confusion, lack of clarity and user friendliness

39% of risk assessors found that the risk assessment questions made it clear what was required in the response (Figure 2). 56% answered that they found this was mostly correct, but had some problems, 5% found this was not the case. Those that answered negatively noted problems such as the use of double negatives, the use of repetitive questions, the lack of a ‘simple’ predefined option(s) for their answer, poorly constructed sentences and irrelevant questions or those that did not apply to their organism.

37% of respondents agreed that the terms used in the risk assessment were clear and unambiguous (Figure 2). 37% mostly agreed with this statement but gave examples where they had had some problems. 17% disagreed. Examples of problematic terms highlighted by the assessors are listed in Appendix 2. In addition, respondents reiterated difficulty with
double negatives and difficulty in categorising their responses into ‘high, medium and low’ categories.

39% of assessors found that the predefined responses covered a complete set of relevant possibilities when answering questions, with 44% finding that there were some problems and 17% finding they were not complete (Figure 2). The main comment was that a ‘not applicable’ category was wanted as an option for all questions. Many assessors commented that the predefined response would not have been relevant if not clarified by the notes attached to questions. One assessor noted that lack of clarity in definitions might have caused confusion in their answers.

![Figure 2. Risk assessor response to ease of use questions](image)

<table>
<thead>
<tr>
<th>Question</th>
<th>Total No. of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you complete the risk assessment alone?</td>
<td>19</td>
</tr>
<tr>
<td>Did you find the electronic format easy to use?</td>
<td>19</td>
</tr>
<tr>
<td>Did the questions make it clear what was required in the response?</td>
<td>18</td>
</tr>
<tr>
<td>Are the terms used clear and unambiguous?</td>
<td>19</td>
</tr>
<tr>
<td>Do the pre-defined responses provide a complete set of relevant possibilities?</td>
<td>18</td>
</tr>
<tr>
<td>Was the user guide clear and useful?</td>
<td>19</td>
</tr>
</tbody>
</table>

iv. User manual

42% of assessors found that the user guide was not clear and helpful (Figure 2); most of these indicated their main difficulty was that it was too long and cumbersome. Of these, four assessors reported that they found the manual difficult to navigate around. Three assessors relayed that they read, or tried to read the manual, but did not refer to it again when completing the assessment. Often assessors relied on the example assessments and embedded notes as a guide, rather than using the manual.
v. Providing standard responses

Few responses were received when assessors were asked to outline their approach to using the standard response categories in the risk assessment spreadsheet. One risk assessor outlined that their approach was to consider the question in percentage terms (e.g. likely = >75% chance of it happening, unlikely = 26 – 50%). Others made qualitative decisions based on logical assessment relating to a similar proportional approach (e.g. it happens in summer and autumn rather than winter so my answer was 'moderately likely'). One assessor indicated that Tables 1 and 2 in the user guide guided them.

vi. Additional information required by risk assessors

Risk assessors were asked to feedback on how useful they had found the additional information and support they were provided with. Copies of example risk assessments to act as a guide, and contact, where necessary, with an informed member of the co-ordinating team, were the two main areas highlighted.

vii. Recommendations of risk assessors

Recommendations for improvement given by the risk assessors were:

- Make the system more user friendly by using a different ‘front end’ for the presentation of the scheme. Some assessors noted that Excel may not be the best tool to use and that database software or another format would be more appropriate. This was highlighted by the inability to include multiple pathways for the organism risk assessment, the inability to navigate easily around the spreadsheet and poor integration with other modules.

- Improve user friendliness by having a non-technical version of the user-guide that would be shorter, simplified and restructured.

- Give guidance for the use of Excel was recommended for those not familiar enough with this software. It was particularly noted that guidance should be provided on how to use the comments and drop down menus.

- One risk assessor commented that the scheme should be tailored to specific groups of organisms.

- One risk assessor wanted a more clearly defined reason for undertaking the assessment.

- One risk assessor wanted a more clearly defined risk assessment area with map.
Value of output

81% of risk assessors responded that the risk assessment correctly identified the species as a risk (or not) in the risk assessment area. 19% partly agreed, with none disagreeing (Figure 3).

64% of assessors considered that there were questions in the risk assessment that made identification of the organism as a risk ambiguous; 18% responded this was not the case, while 18% considered this was partly the case (Figure 3).

Risk assessors were asked whether the risks identified by the scheme were relevant to their organism. 75% responded they were, with 6% in disagreement (Figure 3). 19% neither agreed nor disagreed. 88% of the assessors thought all the relevant risks were identified for their organism with none disagreeing (Figure 3). Two assessors were unsure. The assessor who disagreed felt that too little research was available to be sure what all the risks were for the organism.
Only nine assessors answered the question “is appropriate weighting given to each of the risks”. Of those, 78% assessors agreed appropriate weighting was applied to each question, with 22% disagreeing (Figure 3).

65% of the assessors agreed that the risk assessment took into account all the relevant features of the species they felt were important for the assessment (Figure 3). 29% did not feel this had been done and 6% were uncertain. Comments included “the assessment does not work for medium sized carnivores” and “there are many more variables than just species characteristics.”

75% of assessors answered that they felt relevant impacts for their organism had been identified by the risk assessment (Figure 3). The remaining 25% were split, with 19% neither agreeing nor disagreeing and 6% disagreeing. One of the assessors that neither agreed nor disagreed felt that positive impacts were not considered.

Risk assessors answered that relevant pathways were identified by the risk assessment in 93% of cases, with one assessor neither agreeing nor disagreeing.

78% of risk assessors agreed and 17% strongly agreed that the risk assessment appropriately identified the risks of the subject non-native species (Figure 4). 5% strongly disagreed with this statement.

Figure 4. Risk assessor response to the question “the risk assessment appropriately identified the risks of the subject non-native species”
3.4 The practicalities and problems of using the NNRA from the point of view of a co-ordinating body

Obtaining contacts

For the breadth of experience required to complete a diverse set of risk assessments the co-ordinating body needed to collect an extensive network of contacts. The main sources of contacts were those already known by the co-ordinating team and from this, additional contacts were made through referral. Where no known contacts existed, further details were found through a literature or Internet search. Table 6 shows the source from which each of the final contacts was found.

Table 6. Sources of assessors used in the project

<table>
<thead>
<tr>
<th>HOW THE CONTACT WAS FOUND</th>
<th>NUMBER OF ASSESSORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet searches</td>
<td>5</td>
</tr>
<tr>
<td>Co-ordinator’s contacts</td>
<td>7</td>
</tr>
<tr>
<td>Contacts provided by others</td>
<td>10</td>
</tr>
<tr>
<td>Internal assessor</td>
<td>4</td>
</tr>
</tbody>
</table>

Finding the contacts for some organisms was more difficult than others. Of the 23 assessments carried out (excluding those completed by RPS), nine were completed by the first contact made. Nine more assessments required two people to be contacted before an appropriate assessor was found. Four assessments needed three or more people to be contacted.

In total 11 contacts confirmed/agreed within the first four weeks of starting the search though three were subsequently lost. The remaining contacts were made in the following months, though four assessments were still outstanding at the end of the project.

Experts could not be found to complete four of the risk assessments. These are considered in turn below:

- **Cane Toad.** No risk assessor could be found to assess this species. In total nine people were contacted as potential risk assessors but none felt they knew enough about the species in the risk assessment area (Turks and Caicos).

- **Salmon parasite, *Gyrodactylus salaris.*** Relevant experts who could have undertaken the assessment had difficulty in obtaining permission to work on the scheme as they were part of government agencies. Many of the experts approached had already been involved in a previous risk assessment of this species that was used in the development of the NNRA.

- **Small Hive Beetle.** This was a suggested alternative for the New Zealand Flatworm (see below). An assessor was found; however they could not complete the assessment within the timescale of the project.
Bird escapes from zoos and wildlife parks Pathway. This was a suggested replacement for ‘human assisted transfer of non-native exotic animals into Great Britain’ (see below). The various experts contacted to complete this assessment felt it was too broad for them to cover.

Some of the organisms assessed in the trialling and peer review project were replacements for organisms for which risk assessors could not be found. The original organisms are listed below:

- Pirri Pirri Burr. An expert could not be found to provide a full account of this species in the requested risk assessment area (Great Britain).

- New Zealand Flatworm. The experts contacted regarding this species had been involved in, or had considerable awareness of a previous risk assessment undertaken for this species that was used in the development of the NNRA.

- Asian Long Horn Beetle. Similarly to the New Zealand Flatworm, experts were aware or involved in a previous risk assessment that was used in the development of the NNRA.

- Human assisted transfer of non-native exotic animals into Great Britain. The various experts contacted to complete this assessment felt it was too broad for them to cover.

Initially some risk assessors agreed to take part in the scheme but withdrew after having more time to consider the work that was required of them. This was due to both the time it would take and the difficulties in using the scheme (e.g. problems understanding and reading the user manual). In one case an assessor wished to withdraw from the scheme as a result of difficulties using the Excel format of the assessment. This was addressed and the assessor completed their assessment successfully with no further problems.

The most commonly given reasons for potential assessors not agreeing to take part in trialling the scheme were a lack of time after fully appreciating the scope of the task, or insufficient technical knowledge.

Risk assessor background

84% of assessors reported that their knowledge of the organism / pathway was related to the professional work that they did; 11% responded that it was not related to their work (Figure 5). Of the latter category assessors were either retired or had a general interest in the organism / pathway that was not directly related to their job. Those that responded that their knowledge of the organism / pathway was vocational came from a wide range of backgrounds, including genetic research, researching invasion into parts of the UK, general biological / ecological research, providing policy and management for government departments, practical management in the UK and consultancy. Just over half of the assessors had an interest in their organism because it was invasive. The remaining assessors had a general interest in the biology and ecology of their organism.
39% of assessors reported they had some previous experience of risk assessment (Figure 5). These assessors came from backgrounds in advising government and private consultancy.

44% of the assessors reported that it was possible, in part, that they had a non-neutral approach to the subject of invasive organisms, however most considered this unlikely (Figure 5). 22% of assessors responded that they did not consider their responses could be biased, with one considering that the system was designed to eliminate such bias. 34% of assessors indicated that they had such strong views about their organism; it would have led to their completion of the scheme being considered non-neutral.

Figure 5. Questions regarding risk assessor background

Communication

Good communication between co-ordinators and risk assessors encouraged prompt completion of assessments and allows assessors to come back with any problems they might have encountered. In order to overcome the inherent problem with co-ordinating such a scheme, a colour-coded database was created to keep track of assessors and their progress as several people were working on the project at the same time. Assessors were contacted every 2 weeks to keep up to date with their progress preferably by telephone but alternatively by email. As a result, a large amount of co-ordinator time was spent chasing assessors and contacts.

In three cases, a risk assessor was found, agreed to take part, was believed to be undertaking the assessment and subsequently pulled out. This meant new contacts needed to be found with restricted time to do so.
Providing guidance

Risk assessors were encouraged to contact co-ordinators for guidance in the case of any difficulties. Some assessors needed technical assistance, as those not familiar with using Excel were unsure how to access the pre-defined responses in the drop down boxes or the comments function. In some cases, the trialling team were asked to provide guidance in the meaning and appropriate response to some questions. The trialling team generally resisted this as it was felt this could bias the objectivity of results. As problems were brought to the co-ordinators’ attention, the information initially supplied to risk assessors was updated to include extra information about the use of the scheme.

One risk assessor required a member of the co-ordinating team to visit and assist them in the use of the spreadsheet, as guidance by telephone was not sufficient.

Invoicing

Risk assessors were asked to quote for their work. The figures provided varied widely with a minimum of £270 and a maximum of £2100. The average cost per risk assessment was £935.

Risk assessors were chosen from a wide variety of background and employment. As such, various invoicing details were required, ranging from proof of self-employment to enrolment as ‘casual workers’. International experts required different payment methods to those based in the UK, adding to the complexity of invoicing procedures. As 21 separate invoices were required, the administration element of invoicing required considerable input and time.

Quality Assurance

Although it was not part of the co-ordinators’ remit to produce a final set of completed risk assessments, it was necessary to follow up queries raised when checking through assessments with the assessor. In the future, if a scheme were to be employed, risk assessments would need to be checked and possibly returned to assessors a number of times for revision. Risk assessments could need alteration as a result of technical errors, spelling or grammar errors, errors in the use of the electronic format of the scheme or as a result of misunderstanding a question in the scheme. This process could take a significant period of time to complete.
4 DISCUSSION

4.1 Overall impression

The NNRA scheme was praised for its ambitious aim to provide a generic risk assessment for all organisms and pathways in Great Britain. A significant amount of work had been done to develop the scheme and all of the peer reviewers identified that it included the fundamental components required for appropriate risk assessment. The inclusion of the ability for risk assessors to record uncertainty as well as their response was praised by risk assessors and peer reviewers for being novel and useful.

However, an overall conclusion is that a considerable amount more work is still required. A fundamental consideration identified by risk assessors, peer reviewers and the co-ordinators is the need for improvement in the clarity and simplicity of the scheme. Further development of a systematic validation and calibration process is also highlighted as an essential recommendation.

The main areas that need developing and improving are:

- Practicalities of using and running the scheme
  - Confusion, lack of clarity and lack of user friendliness
  - Practicalities for co-ordinators running the scheme
  - Whether or not a more in-depth electronic toolkit should be developed

- Assessment of the scoring system
  - Lack of guidance when choosing responses
  - Achieving balance in the weight given to different areas of the risk assessment
  - Interpretation of the terms high, medium and low with respect to the output of a risk assessment
  - Discrepancies between NNRA calculated and risk assessor ratings
  - Use of the system to assess risks in both UK and overseas territories

- Content and Scope
  - Does the scheme appropriately cover all aspects of risk assessment?
  - How does the NNRA scheme’s origin in EPPO affect its function and development?
  - Should the scope of the NNRA scheme include already established organisms as well as those that have not entered the risk assessment area?
4.2 Practicalities of using and running the scheme

Confusion, lack of clarity and lack of user friendliness

It is considered essential for a risk assessment scheme to be clear, easily digestible and accompanied by appropriate guidance. This not only encourages assessors to be thorough in their responses, but also is essential to obtain appropriate and comparable data on the organisms or pathways being assessed.

In its current form the NNRA scheme is particularly poor in this regard. 58% of risk assessors and all of the peer reviewers highlighted lack of clarity and user friendliness in the scheme and user guide as a significant problem. The co-ordinators found that there was a need to provide considerably more guidance than available in the current documentation. This was evidenced in the need to provide considerable additional guidance notes, answer questions and support for assessors throughout the scheme, and later in the difficulty in analysing the data due to the lack of clarity.

Key weaknesses and recommendations for improvement of clarity and user-friendliness are discussed below (Recommendations 1-8, Box 1). General issues are presented as well as those specific to the user-guide or risk assessment templates.

i. Weaknesses of the user manual

42% percent of risk assessors responded that they found the user manual difficult to use with a further 32% finding the user manual partly useful (Figure 2). The main criticisms focussed on poor structure, use of language and length of the document.

The Defra Review (Defra 2003) stated that “the purpose of completing the risk assessment has to be clear from the outset”. This also applies to the purpose of individual questions and, hence, what would constitute appropriate answers (Defra 2003). From the outset, risk assessors, and in one case a peer reviewer, found that the manual did not clearly set out the objectives of the risk assessment scheme from the user’s point of view. This led to an immediate lack of direction in terms of the assessor’s contribution to the scheme (Recommendation 1, Box 1).

The structure and language of the user manual was considered by the co-ordinators more relevant to a technical report rather than a user-friendly guide. Evidence for this included the use of technical language throughout the report, the inclusion of large sections that are irrelevant to the user (e.g. the specification of the electronic toolkit, Annex 5, Baker et al
2005), and the abstract and executive summary, which were not designed with the user in mind. The lack of any simple structure to make it clear where to begin and how to complete each section of the risk assessment frustrated five assessors. The result was that a number of assessors reported that they tried to read the manual and gave up, only used the manual briefly where necessary, or didn’t bother to use the manual at all.

It is recommended that technical elements of the user manual should be removed and that only information relevant to the user completing the assessment is provided in the user manual. The length of the user manual should be substantially reduced to encourage assessors to digest it all before beginning assessment, and to regularly refer to it during the assessment. The aim of the risk assessment scheme should be set out in clear English at the beginning of the document with objectives for each different type of assessment so that risk assessors are clear what their involvement is for. A summary of the instructions in the form of a flow diagram should be provided at the front of the manual so that risk assessors can clearly recognise where they are and what is required of them at each stage of the risk assessment process (Recommendation 2, Box 1).

ii. Use of model assessments for guidance

26% of assessors identified that the example assessments provided were a helpful form of guidance as they proceeded through the scheme. It was apparent that example assessments were often used more than the user manual as guidance. This was not only to assist in the interpretation of questions but also to help calibrate the predefined categories used for response.

The provision of example assessments is highly recommended as a form of additional guidance to help direct risk assessors. However, it is essential that the examples given are model assessments with no errors or omissions. During the trialling project it became apparent that the example assessments varied in quality. Many example assessments contained instances where questions had been misunderstood (e.g. 1.20 in the Topmouth Gudgeon assessment), hidden comments had not been read or taken into account (e.g. comments attached to B27 directing assessors to section 2.1 if the organism has already entered and is widely established) or insufficient comment or references were provided (e.g. 1.8-1.11 in the Indian House Crow assessment). Model assessments, excluding any errors and omissions, could be attached as appendices to the user manual; the latter could draw upon examples from the model assessments to exemplify points and help guide the assessor. (Recommendation 3, Box 1).

iii. Weaknesses of the risk assessment template

Format

The format of the risk assessment template was criticised by six (32%) of the risk assessors. Criticisms were often linked to the level of proficiency in Excel expected of the assessors. However, it is important to note that it was not the use of Excel's basic functions that was considered problematic. The co-ordinators did not consider it unreasonable that many of the risk assessors familiar with Excel were not familiar with the use of functions such as
comment boxes or pull down menus. In some cases this lack of understanding caused an inability to complete assessments, or a misinterpretation of questions. A more straightforward system would prevent co-ordinators having to provide so much guidance.

There is a strong concern that using hidden notes (using the ‘comments’ function in Excel) encourages risk assessors to ignore them. This is either because risk assessors do not know how to use the ‘comments’ function, forget to refer to them, or feel that it is not necessary to always refer to them. This is an important issue as they were often found to be essential to providing an appropriate response to questions (Recommendation 5, Box 1). It is recommended that notes like these should be incorporated into the body of existing questions or incorporated in another way so that assessors do not overlook them (Recommendation 4, Box 1).

The use of notes in general is questioned by the co-ordinators. By definition, a note should not be essential to the understanding of a question, but should act as additional guidance where this is necessary. However, there are a number of questions where the question’s meaning is fundamentally influenced by the note. For example question 10 asks:

“Is the organism widely distributed in the Risk Assessment area?"

This is modified by the hidden note:

“If the organism is widespread in the Risk Assessment area and appears to have reached the limits of its potential range either outdoors or in protected conditions, e.g. glasshouses, then a full detailed risk assessment is not normally necessary."

The note fundamentally alters the meaning of the question from one of a widespread organism, to one that has reached the limits of its potential range either in the wild or in protected conditions. Where notes are necessary to aid the interpretation or understanding of a question, they should not alter the meaning of it. It is recommended that questions should be written so that the meaning is clear and that notes, if necessary, should only provide guidance (Recommendation 5, Box 1).

Three risk assessors (16%) and one peer reviewer identified that the inclusion of calculations in the risk assessment template caused confusion. These were both in the main sheet (e.g. cells F30 to G92, I4 to T36) and in additional sheets (e.g. score summary, graphical summary). Although it was appreciated that these were probably left in the scheme for the benefit of later analysis, it is important that these are hidden or separated when being used by assessors. This will also help prevent assessors tailoring their answers to the outcome of the assessment (Recommendation 6, Box 1).

Three risk assessors were confused by the inclusion of the Pheloung Plant attributes spreadsheets and the Fish Invasiveness Screening Kit (FISK) (Question 8). Assessors were unclear what the purpose of these was and how they fitted into the overall scheme, and more particularly why these tools were only provided for fish and plants and not for other groups of organisms; this latter point was also highlighted by one peer reviewer. Another peer reviewer commented that the embedded spreadsheets had not been appropriately incorporated into the overall assessment and may not be necessary as much of the information was collected by other questions in the main module. If the scheme were to be modified so as to include subsets of questions relating to specific taxa, then the likes of the
Pheloung Plant attributes and FISK could be appropriate, however these are inappropriate in their current form (Recommendation 7, Box 1).

**Use of language**

The language used in the risk assessment template requires considerable redrafting (Recommendation 8, Box 1). All of the peer reviewers identified this as a key problem and one recommended “a drastic overhaul to make the system easier to understand and use”.

Many risk assessors clearly struggled to understand the meaning of questions and comments with only 39% reporting that the questions made it clear how to respond, 56% finding this was partly correct and 5% disagreeing completely (Figure 2). The co-ordinators felt language was often ambiguous leaving the meaning of some questions difficult to understand. 26% of the risk assessors reported finding difficulty in the ambiguity of the questions (Figure 2); however, it was apparent from the co-ordinator review of misunderstandings that this may have been underreported. Of the 22 assessments completed during the trialling project (excluding assessments completed by the co-ordinators), 86% were considered to include at least one misinterpretation of a question (i.e. the comment provided did not match or appropriately explain the answer given in the response or uncertainty columns). In some cases even the co-ordinators were unclear of the intention of the question. Vital areas for improvement in language are considered in turn below.

(i) The use of double negatives in risk assessment questions caused considerable misunderstanding and frustration. Questions such as “How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?” and other examples (e.g. question 1.21) should be restructured to provide greater clarity of meaning. It is noted that the use of double negatives is likely to have been included to provide consistency in scoring so that, for example, all ‘very likely’ responses are scored ‘4’. It is considered that this is not necessary as the scoring system could be tailored to each question as necessary.

(ii) Both peer reviewers and risk assessors commented that the use of undefined terminology was a key weakness. A list of terms requiring definition is provided for reference in Appendix 4. This was a significant problem throughout the risk assessment scheme and lead to considerable confusion and a strong possibility of misunderstanding in the completion of the scheme.

(iii) In some cases the definitions given for certain terms were considered poor and added to the confusion. For example, the definition given for invasive non-native species as a “Species whose introduction and/or spread threatens biological diversity. This is interpreted broadly to include threats to the entire ecosystem including human interests.” In essence, the stated definition could include a species that does not spread, but simply poses a risk to the environment or ecosystem. It also blurs the distinction between a species that is non-native but not invasive and a non-native species that is invasive.
Practicalities for co-ordinators running the scheme

i. Recruitment of risk assessors

The recruitment of assessors was not as straightforward as was originally expected. Generally it was easier to find suitable contacts for the more widespread and well-known organisms but more difficult to find contacts for broader taxonomic groups (e.g. genus) than species. It was most difficult to find risk assessors for less well known organisms, and organisms not well known to be associated with the proposed risk assessment area.

Part of the challenge in finding risk assessors derived from the requirement of the project to ensure that assessors came from a range of organisation types (Table 1). In addition, the following essential characteristics of an assessor were identified:

- expertise in the organism/taxon or pathway concerned;
- experience/knowledge of risk assessment;
- familiarity with Excel; and
- an unbiased approach.

In some cases no expert could be found to carry out the risk assessment. This represents a potential problem for the future scheme, which may struggle to find appropriate assessors for the organisms requiring assessment. While in some cases a contact could not be found because suitable experts were not able to dedicate enough time to the assessment, in others an appropriate contact simply could not be found that had expertise of the organism in the relevant risk assessment area.

The Review of Non-Native Species Policy (Defra, 2003) recognised that an assessor might need support from other experts, e.g. in risk assessment or in relation to potential receptors, and this was borne out by the project, six assessors using other experts for support.

The average quote for risk assessments provided by assessors was £935. This was within the anticipated budget of £1000 per assessment; however there was wide variation with a maximum of £2100 for one assessment. This may make it difficult to predict the overall cost of completing many assessments. Costs were influenced both by the background of the risk assessor (e.g. trade industry, NGO, public institute) and by the amount of information readily available for the target organism. Those organisms for which information was lacking required greater research by the assessor and therefore incurred greater cost.

The average quote of £935 is based on the estimate made by the assessor prior to commencing the assessment. Given that, on average, risk assessments took 21% longer than expected to complete, on a simple pro rata basis, the average cost would be £1131.35.

Given time and resources, it would have been advantageous for potential assessors to have attended a workshop(s) on the risk assessment of non-native organisms and pathways. This would have resulted in greater efficiency and accuracy. The curriculum for such training could include the basics of the NNRA and completing a risk assessment, use of Excel, the
aims and objectives of the scheme and a “test” to ensure assessors were competent to undertake assessments.

The co-ordinators formed the view that when the scheme is implemented, there should be a panel of experts established to comment on the selection of assessors and their training, to review completed assessments, and to generally advise on the NNRA as it develops. The members of such a panel would also benefit from taking part in the workshop(s) as recommended above. The membership of the panel should include experts covering the full range of taxonomic groups such as mammals, birds and invertebrates, as well as in risk assessments and pathways.

ii. Removal of assessor bias from the scheme

In order to be used as an effective tool that will enable sound comparisons to be made between the outcomes of assessments for different organisms, and likewise for pathways, the NNRA scheme should encourage greater parity in the responses to questions by different assessors. Ideally the questions should be structured such that assessors with differing views about invasiveness still produce similar (should an assessment of an organism be undertaken by more than one assessor) and comparable results.

When asked, 44% of assessors acknowledged that they may have had a non-neutral approach that could have affected their completion of the assessment, but considered this unlikely (Figure 5). 22% noted their non-neutral viewpoint was likely to affect their completion. 34% of risk assessors responded clearly that they felt their approach was objective and made from a neutral viewpoint.

The trialling project itself was not ideally suited to accurately gauge the impact of assessor bias on the robustness of the scheme’s results as there were no replicates of any given assessment. However, this issue could have an important impact on the results and comparability of the risk assessments and should be considered further (Recommendation 9, Box 1).

iii. Whether or not a more in-depth electronic toolkit should be developed

The original consortium that developed the NNRA scheme provided considerable discussion regarding the need for a more in-depth electronic tool kit (Annex 5, Baker et al 2005). While the trialling project generally found that this would be a useful approach, it was considered that the current scheme could be significantly improved without additional software (Recommendation 10, Box 1). Once the recommendations from this current project have been responded to, the functionality of the adapted scheme could then be reviewed before making further steps towards an electronic toolkit.

Accepting that there are considerable improvements that could, and should, be made before the development of a more advanced electronic tool kit, it is acknowledged that some elements of the scheme may require an advanced tool kit to work appropriately. These issues are discussed in turn below.
(i) The most apparent limitation of the Excel spreadsheet is its inability to allow repeated assessment of different pathways for organism assessment, and different organisms for the pathway assessment. For example, a non-native organism risk assessment requires the assessor to list and assess each pathway along which organisms enter the risk assessment area (questions 1.1 to 1.14). However, the assessor is only able to assess one pathway as there is no function in Excel to repeat the process and store separate data for subsequent pathways.

(ii) An important consideration for the NNRA scheme is to provide a summary display (front end) of the information within each assessment that can be easily digested by interested parties (e.g. industry representatives, policy makers and managers). The scheme indicates the information that would be required for such a display (comments in cell B90), including the need to:

- evaluate the probability of entry and indicate the elements that make entry most likely or those that make it least likely;
- list the pathways in order of importance;
- evaluate the probability of establishment, and indicate the elements that make establishment most likely or those that make it least likely;
- describe the area endangered by the organism;
- list the most important potential economic, environmental and social impacts in the Risk Assessment area, and
- highlight those parts of the endangered area most likely to be impacted.

This information could be combined with the statistical summary in Module 5 to show a breakdown of the total risk and uncertainty allocated to each section (e.g. entry, establishment and spread) as well as the overall risk and uncertainty of the assessment as a whole.

It is envisaged that a summary display could be produced in three ways: 1) an electronic tool kit could be used or developed to automatically extract the key information from risk assessments and summarise it in a pro forma report; 2) the risk assessor could be required to produce their own front end report using the information in the questionnaire and 3) a risk assessment panel could develop a summary report based on the information provided by the risk assessor.

(iii) The Excel spreadsheet format is of limited use for the retrieval and analysis of comparative data. As recommended by the original consortium, database software would be a more appropriate tool to achieve this (Annex 5, Baker et al 2005).

(iv) The current Excel template does not have the capability to store or display more complicated data such as climate models, distribution maps or Word documents. An electronic format capable of doing this may be a useful tool; however these could be simply referenced and attached to the Excel spreadsheet.
(v) If it is decided to develop a more advanced electronic toolkit, a key recommendation of the peer reviewers was that the end user should be consulted to ensure that user friendliness and clarity are achieved.

4.3 Assessment of the scoring system

The scoring system was assessed using the feedback from the risk assessors and the peer reviewers as well as observations made by the co-ordinators. The aspects of the scoring system for which there were significant comments are:

- lack of guidance when choosing responses;
- achieving balance in the weight given to different areas of the risk assessment (e.g. entry, establishment, spread and impact);
- interpretation of the terms high, medium and low with respect to the output of a risk assessment;
- discrepancies between NNRA calculated and risk assessor ratings; and
- use of the system to assess risks in both UK and overseas territories.

Lack of guidance when choosing responses

Risk assessors recorded their responses by choosing from five predefined categories such as very likely, likely, moderately likely, unlikely and very likely. Similarly uncertainty was recorded using low, medium and high. The first five categories were allocated numerical scores from 0 to 4, the latter three from 0 to 2. These figures were used to summarise the outcomes of the assessment.

A key weakness identified by the original consortium (Baker et al. 2005) as well as risk assessors and peer reviewers was the lack of guidance when choosing predefined responses. Risk assessors approached this issue using various methods of interpretation but most relied on qualitative and subjective opinion. One assessor attempted to consider the different options as quantified degrees of probability; for example a likely outcome was one that had more than a 75% chance of occurring. The variation in risk assessors’ approach to this subject is likely to have led to a variation in interpretation of the different categories, and therefore a potential weakening in comparability of results.

Tables 1 and 2 of Module 4 in the user manual (Baker et al. 2005) illustrate a guidance method for choosing predefined categories in relation to economic impact. This provides clear boundaries between each category and improves parity in the assessment of different organisms. Similar tables need to be developed for all of the relevant questions in the risk assessment module. These could either be presented in tabular form or be included in the text of the pull down response. Further work would be required in order to calibrate the likely range of responses for each question in order to refine guidance appropriately. (Recommendation 11, Box 1).
Achieving balance in the weight given to different areas of the risk assessment

Seventeen questions in Section B of the risk assessment are dedicated to establishment of the organisms, sixteen to impacts, fourteen to entry and four to spread within the risk assessment area. Given that the summation statistics allocate equal weight to each question, there is clearly a difference in emphasis between areas (i.e. greatest emphasis is given to establishment, then to impacts, then entry with spread given considerably less than all the others). Spread is a key issue for organisms already present in the risk assessment area. This highlights an imbalance in emphasis towards organisms not present in the risk assessment area, which appears to be a general factor within the NNRA.

Using more questions per section (e.g. establishment, spread, etc.) may have been used to deliberately introduce weighting between the different sections (i.e. entry, establishment, spread and impacts). It was considered that this might explain the repetitive nature of some questions (i.e. superfluous questions were included to increase weighting). It was felt this went against the principle of ‘rapid’ assessment and two risk assessors commented that they found repetition in the scheme frustrating. Peer reviewers suggested that the need for repetition could be removed by allocating an appropriate weighting score to different questions (Recommendation 12, Box 1).

Interpretation of the terms high, medium and low with respect to the output of a risk assessment

The Defra Working Group suggested providing ‘high’, ‘medium’ and ‘low’ risk lists, into which all non-native organisms could be categorised (Defra 2003). This is provided in the NNRA through the use of summary statistics, which use the risk assessor’s responses to categorise the risk rating of each organism.

A criticism of the NNRA scheme is that there is no clear definition of the terms ‘high’, ‘medium’ and ‘low’ in the context of summarising risk. It was assumed the NNRA definitions followed those set out in the Defra Working Group report (Defra 2003) that defines ‘medium’ risk species as “those species for which further work would be required to demonstrate whether there is a significant risk of them becoming invasive and causing problems”. Essentially this defines the category as a stopgap while further research is carried out in order to move the organism into either the high or low risk category. ‘Low’ risk species are defined as those “very unlikely to cause problems,” and ‘High’ risk species are those defined as those “known or likely to have harmful consequences.”

The scoring system used by the NNRA appears not to use the same definitions as the Defra Working Group. Instead ‘high’, ‘medium’ and ‘low’ were generally based on whether the summed results lay in the upper, middle or lower third of the possible range of summed answers. This means that a score of ‘medium’ indicates that an organism is of moderate risk.

The approach of having an additional category of risk, rather than including uncertainty within the risk categories, as the Defra Working Group definitions appear to do, is considered helpful for policy makers and managers in understanding how better to distribute resources. Having a mid point between low and high risk is a practical way of dedicating the
most resources to the worst problems while not ignoring others. The scheme should reflect this (Recommendation 13, Box 1).

**Discrepancies between NNRA calculated and risk assessor ratings**

Risk ratings calculated for the organisms assessed during the trialling project are given in Table 4. This includes the risk assessor’s rating (each assessor was asked to state whether they thought their organism was a high, medium of low risk), the calculated risk rating (the sum of the scores for each question then assigned a rating based on whether it lay in the top, middle or lower third of the possible range) and conditional probability rating (calculated by assigning a probability score to each answer and assigning an overall rating based on whether the final probability lay in the top, middle or lower third of the possible range (i.e. >0.666, 0.334 – 0.666, <0.3334)).

Of the 22 species assessed where assessors provided summary results, ten were categorised in the same way by all of the methods of calculating risk rating (Table 4). Overall the three methods never disagreed to the extent that one categorised an organism as high risk while the other categorised it as low. This indicates that the system is broadly useful; however, considerable refinement is necessary, as 12 assessments returned variation in their calculating of risk (e.g. “medium, medium, high”).

Co-ordinators were surprised by the categories assigned to some of the organisms, both by risk assessors themselves and by the calculated risk rating and conditional probability rating. In some instances risk assessors categorised organisms as low or medium risk, which the co-ordinators considered more likely to be high risk. A discussion for each of the species with surprising results is provided below:

- **Eagle Owl.** The Eagle Owl is a controversial species, with opinion split as to whether it should be considered non-native. The risk assessor for this species found the species did not have intrinsic attributes of an invasive species (Question 8, Section A) and so terminated the risk assessment without need for further progression.

- **Three Cornered Leek.** The risk assessor for this species considered that its current distribution in the risk assessment area was limited by climatic conditions, but given climate change predictions it could spread further. As such the risk assessor recorded this species as high risk. The NNRA scheme recorded the species as medium risk as it does not include assessment of the potential effects of climate change.

- **Himalayan Balsam.** This species could be expected to be high risk as it is a highly invasive non-native riparian plant. However, the risk assessor scored the plant as a low risk, while the calculated risk was medium. The explanation for this is that the species’ impacts were considered low, or not well documented. No direct economic costs could be identified by invasion of this plant. Environmental damage by riverbank erosion was noted, however the author recorded 'minor' impact as there was little documented evidence. Ecological impact to biodiversity was noted, but was considered minimal by the assessor as there is limited research that supported this, and some current research indicates the impact is minor.
• Brown Tree Snake. The assessor considered the impacts and risk of the species to be greater (high) than that calculated by the scheme (medium). This appears to be because the areas where impact was highest (biodiversity loss, loss of ecosystem function and power cuts) did not out-weigh the relatively low scores in other sections (consumer / producer profit, export markets, social harm). This difference in the consideration of impacts led the calculated risk rating to be medium whereas the author considered it high.

Another reason for some of the discrepancies between the risk assessors’ categorisation of their organisms and the scheme’s categorisation is likely to be related to a lack of definition of the three categorised terms and misunderstanding or misinterpretation of the responses required for each question by the risk assessor. In addition, some features of the organism and its management may have been taken into consideration by the risk assessor that were not considered by the scheme (e.g. the ability to control those species that have become widespread).

It is suggested that the recommendations in this report be incorporated into the next stage of the scheme to remove problems of misunderstanding and misinterpretation. Following this, a further assessment of the scoring methods could be undertaken to better refine them for the purposes of categorisation.

Use of the system to assess risks in both UK and overseas territories

A confusing element of the categorisation system is that organisms that affect the UK are grouped with those that affect overseas territories. As a result, organisms such as the Giant African Snail, assessed for its impact on the Caribbean islands, is ranked at the same level or priority as, for example, the Chinese Mitten Crab, assessed for its impact in England, Scotland and Wales. While both may be problematic in their respective risk assessment areas, using the same system to assess their risk is not considered helpful. There are profound differences between the UK and islands such as Anguilla and Montserrat and it is difficult to understand how the scheme can be optimal in providing a helpful tool to advise policy or management in the UK in addition to small islands, some of which are very remote.

This issue is addressed in Section 4.4 (Should the scope of the NNRA scheme include overseas territories?).

4.4 Content and Scope

Does the scheme appropriately cover all aspects of risk assessment?

All of the peer reviewers and 37% (7) of risk assessors complimented the scheme for its comprehensive coverage of the fundamental elements required of a generic risk assessment scheme. 65% (11) of the risk assessors answered “yes” to the question “does the risk assessment take into account all of the relevant features of the species you feel are important for the assessment?” (Figure 3). However, two key areas were considered important to improve: the need for questions tailored to more specific taxonomic groups, and the importance of incorporating more climate data.
Risk assessors in particular were concerned that the production of a completely generic assessment for all non-native organisms would not be appropriate in all cases. Of those that considered the scheme did not appropriately cover the fundamentals of risk assessment for their organism, six (35%) cited the need for more specific questions tailored towards their organisms as the reason for concern. There was also concern that a lack of relevant questions and the inclusion of irrelevant questions reduced the scheme’s value.

The main recommendation from both risk assessors and peer reviewers was to develop question subsets for particular taxonomic groups. At its simplest this could provide questions specific to animals or plants. More detailed subsets could be developed for specific levels of classification (e.g. mammals, fish or flowering plants). The need for additional questions which assess key features only of importance for specific taxa, e.g. the ability to reproduce vegetatively or the need for specialist pollinators relevant only for plant taxa were also identified by Defra (Defra 2003). It is concluded that “consideration may need to be given to producing different versions for different taxa” (Defra 2003). Encouragingly, the idea of question subsets was suggested as opposed to separate schemes for different taxonomic groups. This would help keep the scheme relatively generic and maintain comparability between groups. (Recommendation 14, Box 1).

Peer reviewers universally stressed that climatic assessment was not given enough attention within the NNRA scheme. Only one question appears to be directly relevant to climate assessment, “1.15 How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?”, although some limited consideration of the potential range of the non-native organism in the risk assessment area is considered by questions 2.1, 2.2 and 2.4.

Incorporating climate data is considered important not only to assess the potential range of the non-native organism in the risk assessment area, but also to help predict the effect of climate change on the potential future introduction, establishment and spread of non-natives.

Peer reviewers noted that systems have been developed to map the potential range of non-native organisms in the risk assessment area base on known climate variables. The incorporation of these data would provide a more refined assessment of risk and would be a useful tool in establishing appropriate policy instruments and allocating management resources within the risk assessment area. (Recommendation 15, Box 1). Papers and weblinks for useful climate data are provided in Appendix 5.

How does the NNRA scheme’s origin in EPPO affect its function and development?

The need for pest risk analysis has been recognised for decades and the EPPO scheme is the result of the development of risk assessment schemes over this period and at an international level. The EPPO scheme was developed for pest organisms and has evolved from work on these organisms. In contrast, the NNRA scheme has been developed directly from a pest risk assessment scheme (EPPO) and, whilst as the peer reviewers identified, the NNRA scheme is built on solid ground, it is important to recognise that the NNRA scheme will need to develop to deal more fully with non-native organisms and the differences that exist between these and pest organisms. For example, as evidenced by the choice by the Scottish Executive of organisms to assess (Table 2), there is a current emphasis on risk
assessing those non-native organisms that are already established in the risk assessment area, whereas the scheme from which the NNRA has been developed focuses almost exclusively on assessing pest organisms before they even reach the risk assessment area. In this context, it is not surprising that an overall conclusion of the present project is that a considerable amount more work is still required in the development of the NNRA. (Recommendation 16, Box 1).

It was also considered that the framework surrounding schemes such as EPPO (e.g. funding, resourcing and management) could provide insightful guidance in a similar framework for non-native organisms.

In addition to its dedication to pest risk assessment, the EPPO scheme is implemented and used by personnel trained in this area and familiar with the process. The EPPO scheme itself is subject to scrutiny and development by specialists and experts in pest risk assessment. The issue of non-native organisms is a relatively new area and there are very few personnel with knowledge and/or experience of studying, working with and managing such plants and animals. Expertise in risk assessment of non-native organisms is almost completely absent. The consequence of this is the need for education and training of personnel implementing and likely to be using the NNRA risk assessment process. The idea of training workshops for potential risk assessors is a small part of the education and training that will be needed, feeding back into undergraduate and postgraduate degree programmes as well as structured professional development programmes. (Recommendation 17, Box 1).

For both scheme development and the training and education of personnel, useful lessons could be learned from the model of the EPPO scheme and its support and implementation.

**Should the scope of the NNRA scheme include already established organisms as well as those that have not entered the risk assessment area?**

The Defra Review (2003) states, “It is anticipated that priority for undertaking risk assessments would be afforded to potential or new introductions. A retrospective trawl through long-established non-natives is unlikely to be productive.” The user manual developed for the NNRA scheme confirms that the scheme is “primarily designed to assess whether non-native species that are absent from all or part of the UK can enter, establish, spread and cause unacceptable impacts”. However, the scope of the NNRA is also expanded to include the risks posed by already established and widespread non-native species (although a key point is raised that the objectives for such an assessment must be clear).

The co-ordinating team consider that the integration of already established and widespread organisms into the NNRA scheme has not been fully completed and suffers from weighting towards other organisms. Evidence from risk assessors shows that in many cases it was not clear how to assess already established species (many completed sections irrelevant to these, i.e. Entry and Establishment). It is recommended that further consideration is given to make the risk assessment more relevant to already established and widespread species (Recommendation 18, Box 1).
Should the scope of the NNRA scheme include overseas territories?

The scope of the NNRA is wide-ranging and ambitious. Not only does it set out to provide a generic risk assessment for all non-native targets in England, Scotland and Wales, but also for the rest of the UK and its overseas territories.

The combined area of England, Scotland and Wales (Great Britain) is 209,000km², with a temperate habitat and high density of human population (246 per km²). The overseas territories are considerably smaller and more similar to each other than they are to Great Britain. A separate scheme has recently been developed for the Republic of Ireland and Northern Ireland as a whole and so there appears to be no need to incorporate Northern Ireland, as part of the UK, in the NNRA scheme.

Given the already ambitious nature of the scheme it is considered useful to simplify it where possible. Given the clear differences between Great Britain and its overseas territories, it would appear to be an unnecessary complication to group them together into one scheme. It is recommended that a Great Britain risk assessment scheme could be devised, tested and refined in the first instance. From this it is considered a separate Overseas Territories risk assessment scheme could be developed if necessary (Recommendation 19, Box 1).

Should the scope of the risk assessment be reduced to just organisms and pathways?

A need for simplification in the scope of the scheme is identified in previous sections. Currently the scheme is devised to provide assessment of non-native organisms, pathways, receptors and policy. Given the infancy of the scheme this is considered overambitious. In addition one peer reviewer identified that Policy and Receptor were one step above organisms and pathways and so should be considered separately. It is considered by the co-ordinators that there could be a problem assessing such different elements as receptor and policy within the same scheme.

It is recommended that the scheme should focus on developing the assessment for organisms and pathways (Recommendation 20, Box 1). Following the development of these into a workable tool an additional phase could be undertaken to provide other modules (Figure 6). This phase could link to the understanding and incorporation of methods used by the EPPO pest risk analysis scheme.

<table>
<thead>
<tr>
<th>Box 1. Recommendations arising from the project with respect to the further development of NNRA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Practicalities of using and running the scheme</strong></td>
</tr>
<tr>
<td>1. Clearly define the purpose(s) of undertaking the risk assessment.</td>
</tr>
<tr>
<td>2. Develop a bespoke, user-friendly manual including a stepwise guide to completing the assessment.</td>
</tr>
</tbody>
</table>
3. Provide model risk assessment examples as guidance for risk assessors. These should be thorough, clearly understandable and without mistakes and incorporated into the user manual.

4. Incorporate comments into the body of text rather than as hidden comments.

5. Ensure that comments do not fundamentally change the meaning of questions.

6. Hide the currently visible calculations that do not concern risk assessors.

7. Remove or reassess the use of the Pheloung plant attributes and Fish Invasiveness Screening Kit (FISK) spreadsheets.

8. Use more accessible language throughout the scheme including spreadsheets and the user manual. Where used, any terms that could lead to misunderstanding should be clearly defined and a full glossary provided.

9. Explore the potential for assessor bias in NNRA and determine if measures need to be taken to eliminate any such effect and how.

10. Improve existing format (Excel spreadsheet), before developing a new toolkit (e.g. for additional pathways on organisms assessments). End users should be consulted on the development of any electronic toolkit.

Assessment of the scoring system

11. Undertake calibration of the categorised answers. Develop similar tables to those provided in Module 4 (Tables 1 and 2) for all relevant questions in all risk assessment modules.

12. Carry out further work to introduce a more representative weighting system without the need for repetition of questions.

13. Clearly define high, medium and low risk in relation to the summary scores provided for each organism.

Content and Scope

14. Consider the addition of question subsets to deal with major taxonomic groups (e.g. mammals, invertebrates and plants).

15. Give further consideration to incorporating climate mapping or of climate data that would be required.

16. Acknowledge the immaturity and lack of pedigree in the NNRA scheme in relation to the amount of additional development the scheme will need. The development of the EPPO scheme could be valuable in appraising the scale and nature of development that is likely.
17. Accompany the launching of the NNRA by a programme of training and education to provide personnel competent and trained in its implementation and use. The training and education underpinning the EPPO would be a useful model for what is required.

18. More fully integrate the assessment of non-native organisms established and widespread in the risk assessment area into the NNRA scheme.

19. Make the scope of the NNRA simpler by reducing it to exclude overseas territories.

20. Make the scope of the NNRA simpler by reducing it to exclude receptor assessment and policy considerations.

5 CONCLUSIONS

The NNRA scheme has been demonstrated as essentially fit for purpose. A key outcome of this project 26 completed risk assessments. Whilst caution should be exercised with respect to their accuracy and full value, assessors and peer reviewers have used them to show that the scheme essentially works indicating the significant amount of work that has been done to develop the scheme. Peer reviewers and the majority of risk assessors also identified that the NNRA scheme includes the fundamental components required for appropriate risk assessment. The experience of completing the risk assessments, associated feedback and the reports from the peer reviewers identify that a considerable amount more work is still required and this is captured in the recommendations drawn from the project (Box 1). These recommendations emphasise the need for considerable improvement in the clarity and simplicity of the scheme.

6 REFERENCES


EPPO 1997 Pest risk assessment scheme. EPPO Bulletin, 27 281-305


7 APPENDICES
APPENDIX 1 – Peer reviews
EXTERNAL PEER REVIEW REPORT: RPS/Scottish Executive/DEFRA

PROJECT TITLE: United Kingdom Non-Native Organism Risk Assessment Scheme

AUTHORS: CABI Bioscience (CABI), Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Centre for Ecology and Hydrology (CEH), Central Science Laboratory (CSL), Imperial College London (IC) and the University of Greenwich (UoG).

REVIEWER: 01

Instructions to reviewer
The objectives of the peer review are to:

1. Consider and report on any gaps and weaknesses of the scheme;
2. Consider and report on particular strengths;
3. Suggest any potential improvements to the scheme; and,
4. Comment on comparisons between this scheme and any others you may be familiar with.

Strengths of the scheme

1. **Good conceptual model:** the risk assessment scheme is based on a sound conceptual model that divides the invasion process into four main stages (entry, establishment, spread and impact). It is therefore able to recognise that the processes that determine the likelihood and consequences of each of these steps varies. This is consistent with current scientific understanding (see for example Kolar and Lodge, 2001; Heger and Trepl, 2003).

2. **Habitat classification:** The explicit use of a formal habitat classification scheme (from the UK Biodiversity Action Plan) in the risk assessment scheme is both novel and commendable. A systematic classification such as this helps to minimise linguistic uncertainty and encourages consistency and transparency of approach. These are important goals for any qualitative risk assessment and I believe the use of this habitat classification scheme goes some way to helping the scheme meet these goals (but see also comment 10 below). Note that these types of classifications could be extended to other parts of the risk assessment schema. Hayes et al. (2005), for example, develop a similar classification for the potential impacts of non-native marine species in order to facilitate comparisons across different species and thereby rank their relative importance.

3. **Recognises parametric uncertainty:** The risk assessment scheme acknowledges that assessors who use the scheme may have uncertain responses, and explicitly allows for this (parametric) uncertainty in the risk calculation (but see also comment 12 below). This is an important, but often overlooked, component of a risk assessment scheme. Note that similar, interval-based, approaches to parametric uncertainty have been successfully employed in other risk assessment schemes such as Hayes et al. (2005) and Nyberg and Wallentinus (2005). The scheme’s authors also note that the credible range of the risk assessment response will sometimes span important risk management boundaries – i.e. low to medium or medium to high. This could have important implications for how managers use the results of the risk assessment scheme. I would encourage the authors of the UK scheme to discuss this with the agencies who will use the results of the scheme.

4. **Recognises scoring summation issues:** The scheme recognises that the score summation process can have a strong influence on the results of the risk assessment scheme. Again this is an

---

1 Pers. comm. Olaf Booy, 3rd November 2006
important, but by and large overlooked, facet of these types of risk assessment approaches. The scheme explores the effect of the summation method using three methods compared across four risk assessment examples (Table 2, Module 5). I would encourage the scheme’s authors to explore the effects of this issue for a large sample size, as and when the number of questionnaire returns increases.

5. **Recognises the potential for correlated responses:** The scheme recognises the potential for correlated question responses. Correlation between the responses will have a strong influence on the results of the assessment and, importantly, on the effect of uncertainty on the results of the assessment (see comment 12 below). I would strongly recommend that the authors explore the effects of correlation as and when the number of questionnaire returns increases.

### Gaps and weaknesses of the scheme

6. **Pathway classification:** The pathway classification could be improved. Attachment A shows a simplified version of a much more comprehensive pathway classification developed by the Invasive Species Pathways Team of the US Invasive Species Advisory Committee (ISAC). I have also included as a separate file (attached to the email with this document) the full classification scheme developed by the ISAC. I would encourage the authors of the UK non-native risk assessment scheme to consider, or even adopt, this classification for their purposes.

7. **Plant and fish screening:** The UK non-native risk assessment scheme uses the Australian weed risk assessment schema (Pheloung *et al.* 1999) to identify potentially invasive plants. The UK scheme also uses an apparently similar approach to identify potentially invasive fish. The authors of the UK scheme should note that there is compelling evidence that the Australian weed risk assessment scheme is overfitted (see [http://en.wikipedia.org/wiki/Overfitting](http://en.wikipedia.org/wiki/Overfitting) for a succinct description of overfitting).

Caley and Kuhnert (2006) tested the Australian weed risk assessment scheme and discovered that an optimal classification tree for weediness included only 4 out of the 44 attributes of introduced plants used in the scheme, namely: (i) intentional human dispersal of propagules; (ii) evidence of naturalisation beyond native range; (iii) evidence of being a weed elsewhere; and, (iv) a high level of domestication.

Moreover these results accord with a recent analysis by Hayes and Barry (in revision – refer to Attachment B) that identifies only 3 event-level characteristics that are consistently, significantly associated with establishment success, namely: (i) climate/habitat match; (ii) history of invasion success; and (iii) the number of arriving/released individuals. Importantly this study did not identify any statistically significant species-level characteristics that were consistent predictors of establishment or invasion across different taxa. Rather the study suggests that characteristics of successful invaders are likely to be taxa- and site-specific (see also the ‘key-lock’ models of Heger and Trepl 2003). I recommend that the authors of the UK non-native risk assessment scheme consider the implications of these findings for their work.

8. **Screening other taxa:** The UK non-native risk assessment scheme is designed to evaluate the potential for *any* non-native organism to enter, establish, spread and cause significant impacts in the UK. It is important to recognise that the scheme could therefore be applied to hundreds if not thousands of non-native species that potentially threaten the UK. Data compiled by an Australian project team, for example, identifies at least 1500 marine species with a documented invasion history somewhere in the world – and this is only for the marine environment. In light of the size of the potential problem it would be advantageous if the UK scheme were able to quickly screen potential non-native species, subjecting only sub-set of the total number of potential invaders to the full risk assessment process.

The UK scheme currently has a method to screen fish and plants (but see comment 7 above) but does not appear to provide an equivalent method for any other taxa. In my opinion this is an
important omission. I recommend that the authors of the UK scheme develop a relatively simple, but as far as possible robust, screening methodology that can be applied to any non-native organism. A recent analysis of consistent predictors of invasion success (Hayes and Barry in revision) suggests that event-level characteristics (such as prior invasion history and climate match) would be a good place to start.

9. **EcoClimatic similarity:** The current qualitative analysis of ecoclimatic similarity in the scheme (Stage 2, question 14 and Section B, question 1.15) is weak and a long way from world best practice. I recommend that the scheme’s authors consider adopting one of a range of quantitative methods to measure climate and habitat similarity and thereby predict the potential distribution of a non-native species in the UK. Elith et al (2006) provide an excellent review of potential techniques in this context. The scheme’s authors could also refer to Bomford et al (2005), Bomford and Glover (2004), Lester (2005) and Hayes and Sliwa (2003) for examples of quantitative approaches to climate suitability modelling applied across a range of different taxa.

10. **Impact classification:** the UK scheme offers no classification of potential impacts in an equivalent format to the habitat classification. Inclusion of an impact classification may improve the transparency and consistency (for the same species across different assessors) of the scheme.

11. **Vague and underspecified terms:** the scheme provides definitions for some but not all of the terms that it uses. For example terms such as “rapidly” (Stage 2, question 17), “slightly similar”, “similar”, “very similar” (Section B, question 1.16) “few”, “moderate”, “many” (Section B, question 1.17), “slow”, “intermediate”, “rapid” (Section B, question 2.2) and “easily”, “difficult”, etc (Section B, question 2.3) are undefined. These terms are currently vague and underspecified – meaning that their interpretation will vary depending on the context in which they are answered. Different invasive taxa, for example, are known to spread at very different rates (see Arim et al. 2006). The term “rapid spread” could therefore mean different things depending on which taxa is being assessed. I recommend that the scheme’s authors define and/or test the effect of different interpretations of these terms by comparing the results of the assessment for the same species across different assessors.

12. **Monte Carlo simulation on correlated responses:** the UK non-native risk assessment scheme uses Monte Carlo simulation to explore the effect of parametric uncertainty in the assessor’s response to each of the scheme’s questions. The scheme’s authors acknowledge that the responses to each of the questions is unlikely to be independent – i.e. at least some are likely to be correlated. They do not, however, acknowledge the effect that this may have on the uncertainty of the overall risk estimate. If the response to questions are correlated it is important that this relationship is reflected in the Monte Carlo simulation otherwise the overall effect of uncertainty on the risk assessment results may be underestimated (see for example Ferson and Burgman 1995 and Ferson 1996). The effect on the overall uncertainty of a risk estimate associated with simple linearly correlated input variables can be explored in Monte Carlo simulations using packages such as @RISK (http://www.palisade.com.au/risk/default.asp) or coded directly into a visual basic macro using routines available in the literature (see for example Iman and Conover 1982). I recommend the authors’ of the UK scheme integrate a dependant, correlated structure into the scheme’s Monte Carlo simulation if, as suspected, correlated responses are detected in the questionnaire returns.

13. **Bayesian conditional probability:** The UK scheme uses a novel Bayesian approach as an alternative to simple summation of risk scores to arrive at an overall risk estimate. In my opinion this is a commendable attempt to address an important issue in risk scoring schemes such as the UK scheme (see comment 4 above). I am a little uncomfortable by the practical implementation of the Bayesian approach within the context of the UK scheme, for a number of reasons:

a. the authors justify two very important assumptions – the scale mid-point is associated with an equal probability that a species is or is not a successful invader and the prior odds that the species is invasive is 1 – on the grounds that the risk assessment scheme only provides
a relative rather than absolute measure of invasion risk. The risk assessment manual, however, does not emphasise this point and I am concerned that some users of the scheme will miss this distinction. When using the Bayesian approach outlined in the manual, it is very important that the authors emphasise that the scheme does not provide an absolute measure of risk and will not provide an indication of the actual probability of establishment or impact of a non-native species until such time as the scheme has been thoroughly “trained” against a set of known successful invaders. I notice that this important distinction is not emphasized in Holt (2006) but is handled much better in Holt et al (2006). I recommend that the approach adopted in Holt et al (2006) to this issue is emulated in the scheme’s manual and that language used in the manual reflects the relative output of the assessment – e.g. use the word “higher” risk rather than “high” risk.

b. the sensitivity of all risk assessment schemes for non-native species may suffer, to a greater or lesser extent, because of a “low base rate” - i.e. a low rate of species that in reality will become successful invaders (see Smith et al 1999 and Lonsdale and Smith 2001), as also reflected in the well known “tens rule” (Williamson 1993). If the base rate is indeed low then the priori odds that a species will become a successful invader will also be low. Moreover the actual prior odds of a successful invader are likely to be taxa-, site- and pathway-specific. Both of these factors, if true, will make it very difficult to successfully “train” a scheme, such as the UK risk assessment scheme, that is designed to be applicable to any taxa on any pathway for all habitats in the UK.

c. the Bayesian approach assumes that the assessor’s response to all questions are independent when in fact this is unlikely to be true (as acknowledged by the scheme’s authors). The effect of correlated response, although relatively minor, will also serve to further confound attempts to translate the UK scheme from a relative measure of risk to an absolute measure of risk.

Potential improvements to the scheme

14. Tier, tailor and train: On the whole I believe the scheme is very ambitious and would benefit from a more explicitly tiered approach wherein the first tier provides a quick, simple, but robust way to screen species. I also suspect that the scheme will prove very difficult to successfully “train” because of site-, species- and pathway-specific factors. If site-, species- and pathway-specific factors are indeed important determinants of invasion success, then the authors of the UK scheme will probably have to collect hundreds of responses in order to successfully train an assessment as large as theirs, without any guarantee that the scheme, as currently laid out, can actually deliver a high level of sensitivity. I recommend that the authors compare this scheme with other equivalent taxa- and pathway-specific schemes (see references provided in this review) and consider ways in which the scheme might be tailored to specific applications.

15. Maintain a relative measure of risk: If the scheme is not trained, but rather maintains a relative measure of risk, then this must be emphasized within the assessment documentation and the risk management implications carefully evaluated and communicated to agencies which are going to use the results of the scheme.

16. Other detailed recommendations: Specific, detailed recommendations for potential improvements to the scheme are embedded within most of the comments above.

Comparisons with other schemes

17. Schemes already highlighted in this review: this review highlights a number of (more or less) similar risk assessment schemes that the authors’ of the UK scheme might refer to for comparative purposes; namely: Bomford et al (2005), Bomford and Glover (2004), Lester (2005), Hayes et al. (2005) and Nyberg and Wallentinus (2005). The scheme’s authors will also find a comprehensive
list of studies that identify statistically significant correlates of establishment and invasion success in Hayes and Barry (in revision).2

18. Cunningham et al., 2003: The UK non-native risk assessment schemes, like many equivalent schemes, uses expert judgement to score a range of species’ attributes to arrive at an overall invasion risk estimate. A recent alternative, inverse, approach uses general linear models to quantify the contribution of species attributes to an expert’s judgement about the invasion risk posed by a species (see Appendix D of Cunningham et al., 2003). This alternative approach is novel and offers a number of advantages over the more traditional methods. I recommend that the authors of the UK scheme consider this alternative approach.

2 This (draft) reference can be provided to the scheme’s authors on request
References


Hayes KR and Barry SC (in revision) Are there any consistent predictors of invasion success?


Attachment A: Figure 2 from Lodge et al (in press) showing the major pathways by which nonindigenous species enter the U.S. and are transported within the US. For the right-hand branch of pathways (Commerce in Living Organisms), each pathway also entails the possibility of other species hitch-hiking on or in the species that is the focus of trade, or in the medium (e.g., water, soil, nesting material) or food of the focal species. Hitch-hiking organisms could include parasites and pathogens of the species in trade. The figure is revised and simplified from the 29 October 2003 Final Report by the ISAC Invasive Species Pathways Team of the Prevention Working Group (http://www.invasivespecies.gov/council/wrkgrps.shtml).
Attachment B: Abstract from Hayes and Barry (in revision)

This article summarises the results of 46 studies (39 different data sets), that identify correlates of establishment and invasion success across 7 plant and animal groups. The studies reviewed here tested the significance of 74 (84) characteristics against establishment (invasion) success using linear models, chi-squared tests and a variety of other parametric and non-parametric techniques. Three event- and location-level characteristics – climate/habitat match, history of invasive success and number of arriving/released individuals are consistently (independently verified by at least two studies in two or more biological groups) significantly associated with establishment success. None of the species-level characteristics identified here are consistently associated with either establishment or invasion success. The fertilisation system of plants (monoecious, hermaphroditic or dioecious) is significantly associated with establishment in two independent datasets. For plants, there are three characteristics related to fecundity (flowering phenology, interval between seed crops and length of juvenile period) that are significantly associated with invasion success in at least two independent studies. Similarly for birds, broods per season, has been shown to be associated with invasion by two independent studies. These patterns, however, are not repeated in other biological groups. Taxon is associated with invasion and establishment success in plants but contraindicated in other groups. This results add weight to the argument that species-level characteristics that are truly predictive of successful invaders are taxa—specific, whereas event- and location-level characteristics are more general. They also impose a tension between the generality and the accuracy of risk assessment schemes that rely on species-level characteristics to prevent introductions. We suggest that site- and taxa-specific analysis of introduced species, particularly accidental introductions, will provide further useful insights. We recommend the use of General Linear Mixed Models as a way to easily interpret the effects of confounding variables such as phylogeny and propagule pressure.
Review of the UK Non-Native Organism Risk Assessment Scheme

Peer Reviewer 02

PREPARED FOR:
RPS Group for the Scottish Executive

DATE: November 2006
Introduction

The UK government, through the Scottish Executive and Defra, are developing a non-native risk assessment scheme to help identify the possible risks posed by these species to the UK and its territories. The scheme has been developed by a number of organizations including: CABI Bioscience, Centre for Environment, Fisheries and Aquaculture Science, Centre for Ecology and Hydrology, Central Science Laboratory, Imperial College London and the University of Greenwich. RPS has been commissioned by the Scottish Executive to coordinate the trialing and peer review of the risk assessment scheme.

The UK Non-Native Organism Risk Assessment Scheme provides a procedure for the assessment of the risks posed by any non-native organism to species, habitats or ecosystems in all or part of the UK. Risk assessments of the pathways that may carry non-native organisms and of receptors that may be vulnerable to non-native invasion can also be carried out by this scheme. In addition to the assessment of specific cases, it can also be used to help inform policies on invasive non-native species.

The scheme is divided into two principal parts. In the first part, the assessor determines whether a detailed risk assessment is warranted by quickly answering a series of 14 questions. The second part contains the detailed risk assessment scheme with 51 questions designed to assess the potential for entry and establishment of the species, the capacity for spread and the extent to which significant economic, environmental or social impacts may occur. The assessor is required to choose one of five levels of responses (very low, low, medium, high, very high) and one of three levels of uncertainty (low, medium, high), justifying these with a written, referenced comment. Guidance is provided on the procedures that should be adopted when information is lacking or highly uncertain.

Objectives

The objectives of the peer review were to:

a) Consider and report on any gaps or weaknesses of the scheme;
b) Consider and report on particular strengths of the scheme;
c) Suggest any potential improvements to the scheme, and taking into account comparisons between this scheme and other relevant risk assessment schemes.
Comments

Gaps, weaknesses and strengths

- The scheme is comprehensive in its coverage of the issues around risk assessment for invasive species, as would be expected given that substantial parts of it are based on existing well established and proven schemes. There are no major gaps and the scheme makes appropriate use of input from other similar schemes. The novel treatment and discussion of scoring and summarising risk and uncertainty (modules 4 and 5) are excellent additions to the scheme. Documentation of evidence supporting choice of answers to questions is a key strength of the scheme, as is the treatment of uncertainty. The principle weakness of the draft scheme is structural – in its present format it is not easy to use (see next section for detailed comment). Another potential issue with the scheme is that effective documentation of reasons for answers to questions requires a substantial undertaking from reviewers – but if the scheme is to go beyond simple expert opinion, then that justification is essential.

- The current scheme is quite long and complex. At times there can be very urgent need to make decisions about response to recently discovered incursions of exotic organisms. Such a process could be facilitated by a rapid assessment process based on the key sections of the current draft scheme.

- In a similar vein, there is a need for a process to prioritise among possible candidates consider for risk assessment as the full assessment requires a significant input of time to complete properly.

- Section A is designed to determine the need for full assessment. The robustness of the procedure needs fuller evaluation, particularly where decisions are made with very high uncertainty.

- There is a global movement to make electronic data more available and to use systems that allow for greater interoperability. Information is the key to effective biosecurity risk assessment. More thought therefore needs to be given to information technology issues relating to the risk assessment scheme and its links to information and similar assessment processes globally (e.g. the Global Invasive Species Network www.gisinetwork.org).

- May of the risk assessment schemes with which I am familiar make routine use of methodologies such as climate mapping (e.g. Climex www.csiro.au/csiro/content/standard/ps1h3,,.html) and/or statistical techniques that extrapolate from known ranges ( e.g. GRASP http://cat.inist.fr/?aModele=afficheN&cpsidt=14361739) to provide information about likely ranges of potential, newly arrived or spreading invasive exotic organisms. It is not clear to what extent the proposed scheme will also routinely use such tools and approaches as opposed to reliance solely on expert opinion. For example, the use of tools such as Climex can provide helpful input into assessment of changes in risk from climate change.

- Other criteria that could be usefully linked to the assessment include those for decision making around eradication versus alternative management options.

- In the proposed scheme, the criteria and process for reviewing assessments with high uncertainty are not clear.

- I applaud the Bayesian approach used in the assessment scheme, and support the further development of that approach, particularly the inclusion of prior estimates of risk.
based on expert opinion, which can be updated with new information at subsequent re-assessments.

- Terminology relating to invasive species may be a problem where the assessment is conducted by experts from outside the UK. For example, the current assessment equates invasive with harmful, which is not always a common interpretation.
- I strongly support a central meta-database of assessments completed under the scheme as a vital source of information for retrospective analysis of the scheme’s performance.
- There is an issue about the repetitive, and therefore non-independent, nature of some of the questions, and the potential impact of that on overall scores for each section of the assessment. I appreciate that overall scores are weighted by number of questions, but not all questions are answered in each section in every assessment. The large number of questions may mitigate the impact of any individual question, but I think there is an issue here that needs reconsideration. The process of reconsideration may result in a smaller set of questions with no loss of discriminatory power, which would in turn make the assessment easier to use.
- In a similar vein, there is no weighting of scores, either from individual sections or across sections (entry, establishment, etc) in determining overall scores. A number of schemes with which I am familiar use weighting systems. This is something for the scheme developers to consider. In the proposed scheme, it wasn’t clear to me how the overall risk scores for entry, establishment, spread and impacts were combined into a single overalls score. Since I believe there is value in weighting each of these 4 categories (on a case by case basis), I am dubious of the value of calculating an overall score.
- Outputs from risk assessment schemes are usually key inputs to decision making about priorities for action between pests. This not something that has been treated in any detail in the current scheme (accepting it may not have been part of the initial brief). But it raises an issue about where the risk assessment scheme fits into the broader scheme needed for decision making about regional or national priorities.

Issues relating to structure and content of current draft scheme

User manual and modules
- There is a need to put the risk assessment scheme in its wider context as part of an overall strategy.
- Given the main scheme has associated with it a number of modules, it would be very helpful if there was a flow chart of the process at the beginning of the manual. This would also help clarify structural terminology (e.g. modules, stages, sections, etc) which I found quite confusing at the start.
- The language and wording of questions and explanations needs a drastic overhaul to make the system easier to understand and use. Examples of this have been provided on an annotated copy of the user manual.

Module 2 Pathways
- Some questions (like P4, P6) need standardisation – low, medium and high may mean different things to different assessors.
- P5 – the issue of deliberate disposal of exotic fish into waterways raises an issue abut the definition of intentional vs unintentional
P10 – use of word ‘volume’ is confusing
P12, P13, P14 these seem more pertinent too establishment than pathways
P15 – not clear what is meant by containment. Where does inspection/surveillance at border fit in the module?
Categories of pathway – other systems I have seen refer specifically to fishing, construction industry, military operations and aid operations as pathways

Module 3 Receptors
- The term ‘receptor’ should be replaced with a word or phrase that is easier to understand
- R2, R3 refer to the UK – should this be “risk management area”?
- R5 – how does the system deal with multiple habitats?
- R7 should read “If the receptor is one or more habitats…”
- R9 is impact considered one invasive species at a time or all together? What defines “wide-spread”?
- The wording that is used in R12 to define the measure should also appear in R9

Module 4 Economic impact
- Not clear if monetary loss includes health, environmental and social/cultural impacts translated into $ values.
- Response costs should be separated out from monetary loss
- In considering key values to be estimated a different interpretation is needed for some questions if eradication is being considered compared to control.

Module 5 Summarising risks
- Breakdown by major categories – the role of spread as a factor in establishment should not be underestimated. Spread is not solely an influence on impact.
- 3.2 The allocation of probabilities to low, medium and high categories is at present an arbitrary one. This is an area that should be revisited, perhaps by creating a larger number of categories. Retrospective risk assessment may provide data that could guide this.
- 3.2 Probability conversion parameter gives equal weight to each question and argues that this probably doesn’t matter too much because of the large number of questions. This is an issue that requires further investigation, particularly if an attempt is made to streamline the questions.

Module 6 Risk management scheme
- Other considerations than reliability need to be taken into account, particularly where eradication is an option
- The principle of recorded justification of choice used in the risk assessment should equally apply to the risk management module.

Annex 4 Gaps and areas for further work
- Pathway risk assessment will ultimately only be improved by better data on border interceptions. The ongoing development and use of the risk assessment scheme therefore needs to be linked into improved access to such data.
- Further work is needed on how to combine risks to different values – economic, social/cultural, environmental, health.
• Valuation of non-economic losses remains a difficult area, but one which is under active research.
• There is a need for ownership of the risk assessment scheme to be clearly enunciated so that ongoing development can be planned taking into account best global practice. Ownership would also allow greater opportunity for productive links to be developed with other countries operating similar risk assessment schemes.

Annex 5. Electronic toolkit
• One of the lessons I have learned from my involvement in a number of similar projects is the need to involve the users of the ‘product’ in its design from the outset. This is not merely a requirement to do with ease of understanding and operation but also more fundamental issues such as software compatibility with users’ IT systems, PC-base vs web-based systems, etc.
• The risk assessment system is, in effect, a decision support system. Specialised software is available for DSS and/or expert system development. The appropriate mechanism for delivery of this ‘product’ to users is something that needs careful consideration and discussion with users.
Introduction

This report was prepared at the request of RPS Group Plc to provide a peer review of a UK Non-Native Risk Assessment Scheme (UKNNRA) prepared for the UK Department for Environment, Food and Rural Affairs (Defra). The review was based on the content of a user manual and MS Excel spreadsheets, including example analyses, that described the proposed system.

The UKNNRA is largely based on the European and Mediterranean Plant Protection Organisation (EPPO) Guidelines on Pest Risk Analysis, adapted to be more generally applicable and incorporate a numerical system for amalgamating ratings.

The terms of reference for the review were to:

a) Consider and report on any gaps or weaknesses of the scheme;
b) Consider and report on particular strengths;
c) Suggest any potential improvements to the scheme, and
d) Comment on comparisons between this scheme and any others you may be familiar with.
The bulk of the work was done at a two day face-to-face meeting between the authors. We discussed our overall impression on the approach and structure of the scheme and then worked through and discussed the individual questions. In addition to this report, we provided detailed commentary directly in the comments column of the two Excel spreadsheet templates (Main Module and Receptor module).

**General comments**

Our general impression was that considerable effort had gone into preparing a large body of work that captures all the fundamental components and that significant progress that had been made. The approach of devising a generic scheme, universally applicable to any invasive organism or pathway, is ambitious but feasible. However, we feel much work remains to be done on the scheme as supplied and that a systematic validation and calibration process is essential.

The specification of starting point and drivers for commencing an assessment is somewhat confusing and could be more prescriptive and clearly set out. We felt that a one page summary diagram of the structure, in the form of a flow chart for example, would be of considerable assistance. The diagram would show the main elements of the main module, the links to the other modules and the exit points. The diagram could also illustrate where loops in the cycle occur to manage multiple organisms and/or pathways.

Although the system is intended to generate an overall assessment of the risks associated with an initiating factor and the user is required to prepare a list of organisms/pathways at step 1 of stage 1, the Excel based system as presented really can only deal with one organism and pathway. We acknowledge that the Excel environment is just an intermediate stage and that a more adaptable software environment may be needed to fully implement the system.

It may be worth considering customised versions for assessing subsets of organisms (e.g. plants vs animals) or pathway types (e.g. intentional vs. unintentional) so that irrelevant questions can be removed (i.e. avoid the need for the NA option) and the remaining questions can be made more specific to the context.

While reviewing the system, we examined a number of the sample assessments and incorporated these observations into the comments that follow. A common observation was that assessors often misunderstood the meaning or sense of a question and answered inappropriately. For example, sometimes assessors wrote ‘unknown’ in the comments column yet give a zero uncertainty score (when it should be maximum uncertainty). This demonstrated the need for more direction on the use of the system to deal with limits of knowledge.

**Uncertainty:**

The precautionary approach (or principle) is referred to but not explicitly defined. We suggest that the last sentence of the 2nd paragraph of the Uncertainty section be quoted as the definition and that Guiding Principle 1 just be referenced:
“Lack of scientific certainty about the various implications of an invasion should not be used as a reason for postponing or failing to take appropriate eradication, containment and control measures”

The quote in the third paragraph is almost undecipherable and it is not clear what the action is when the condition in the quote is met. We think, in relation to the UKNNRA, the intent is that the users of the system act on the basis of the highest risk outcome arising from a repeated sampling of the results using the Monte Carlo approach. Can this be more clearly stated?

It may be useful also to quote from Article 5 Clause 7 of the Agreement on the Application Sanitary and Phytosanitary Measures (SPS Agreement). This is a version of the precautionary approach but imposes an obligation to resolve the uncertainty within a reasonable period of time:

“In cases where relevant scientific evidence is insufficient, a Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information, including that from the relevant international organizations as well as from sanitary or phytosanitary measures applied by other Members. In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the sanitary or phytosanitary measure accordingly within a reasonable period of time.”

Initiation (Stage 1)

The objectives, subject, initiation and risk assessment area relate to establishing the context, the first stage in risk analysis process (e.g. see AS/NZS 4360: Risk Management). This needs to be clearly defined for the benefit of the subsequent assessments. There was some discussion amongst the Panel as to whether policy and receptors were one step above organisms and pathways, as consideration of either of the former two leads to formal risk assessments of either or both of the latter two.

Objectives

The first dot point in the introduction correctly specifies that the objective of the assessment should be defined at the outset (as opposed to the initiating factor). This, for example, may be to determine the need for risk management measures to prevent introduction of a non-native organism, to implement or revise legislation dealing with the management of a non-native organism or pathway, or to prioritise issues (e.g. emerging non-native organism threats or threatened receptors) for resource allocation. While a space exists in the template for specifying the objective, the user would benefit from clearer guidance and possibly a representative list of objectives to choose from.

Subject

Following objectives, the subject of the UKNNRA is essentially either a non-native organism or a pathway and should be confined to these options (see above).
**Initiation**

Only at step 1 of Stage 1 (initiation) does one of the four options need to be specified.

1a suggest GMO as a subpoint
1b essentially an organism list is developed at this point – we don’t see the need to go beyond question 3 of the pathway module at this stage (note further reference to this module later in the report).
1c somewhat daunting task to list pathways and then organisms (note comments on receptor module later in report).
1d even more daunting as described but in practice the organism or pathway should be self evident.

**Risk Assessment Area**

A key concept in the scheme is the Risk Assessment Area (RAA) but this is not defined and consequently led to misunderstandings in the trial assessments we saw. It should be explained in the introduction and defined (along similar lines to the definition of Area and Endangered Area in ISPM 5) so that step 2 of stage 1 can be answered.

**Organism Risk Assessment (Stage 2 Section A)**

This phase is essentially risk identification (e.g. see AS/NZS 4360: Risk Management).

Once the RAA has been defined and the taxonomy resolved (steps 5 & 6) it would be more appropriate to complete steps 9 & 10 next, since the current status of the organism in the RAA is a critical determinant of the need for an assessment in relation to the stated Objective.

In the spirit of a rapid screening process, the remainder of Section A could be summarised as a simple checklist, a positive response to any of which would terminate the analysis. For example:

- Climatically unsuited (including consideration of biotic prerequisites and protected conditions)
- History of opportunities to establish beyond native range but no record of doing so or becoming invasive
- For organisms present in RAA, no record of invasiveness after sufficient time to become so or not under official control and not widely distributed

Terminating the assessment, by arriving at step 20, implies that the organism is non invasive. In fact the assessment can also be terminated if invasive organisms are, for example, too widespread to warrant further assessment.

We don’t think consideration of intrinsic attributes should be part of the initial screening since it probably warrants more than a rapid analysis if it is to be a means of eliminating a species from the assessment. The invasive attributes spreadsheet variants (module 1) don’t seem to be well integrated into the system and it is not clear how the outcome of those systems would be transferred into the main module. Many of the issues addressed in those spreadsheets are addressed by the remainder of the system anyway. We suggest that they be offered as an
alternative the user may wish to use to see if a similar result is produced, rather than as an integral part of the system (additional comments on Module 1 later in this report).

Organism Risk Assessment (Stage 2 Section B)

All of the response types are summarised in table 2 of module 5 but, with the exception of likelihood (table 2 Module 4), there isn't much in the way of clear definitions for these categories. Also the user should be clearly directed to the discussion of these categories in advance of commencing the assessment. The discussion should provide indicative examples that would help to ensure uniformity in the way different assessors rate the questions.

In an attempt to maintain consistency in the ranking system, a number of the questions are awkwardly worded and difficult to interpret (e.g. double negatives) – interpretive difficulties have clearly occurred for some of the questions attempted in the sample assessments. In the annotated template we have indicated where alternative wording would be better. Since the scoring should be automated and hidden from the user, changes to the ranking order of category responses should be easily accommodated.

A number of the questions will be difficult or impossible to answer because of limits to current knowledge (eg question 1.20). We've flagged those in our comments in the Excel template.

We appreciate that the system as presented assigns equal weight to each question (with the capacity, through the scaling parameter, to apply varying weight on a relative basis to the questions in the future). Nevertheless, the influence of some important factors may be excessively diluted: e.g. climatic suitability is a key determinant of establishment potential but is only one of 17 questions of equal weight in this group. By comparison the spread section contains only three scoring questions so the individual questions will have far greater influence on the spread outcome and hence the overall outcome. It may be useful to combine some related questions in part to address this and to simplify the system.

Pathway analysis

A user of the system should be prompted to choose pathway types from a list.

Issues in Module 2 (pathway analysis) are largely duplicated in the main schedule although the process and scoring are different (and it is not clear how the scoring in module 2 should be used). Other than providing background information and prescribing a process for identifying individual pathways, the module is redundant. Because multiple pathways may be involved, it may be better to consider all the pathway-related questions within the module (but using the 5 level scoring criteria) and returning one overall result for each pathway, again as a 5 level outcome. Adapting the conditional probability analysis for a hierarchical system would require some thinking, however (additional comments on Module 1 later in this report).

Although step P2 in the pathway module covers the description of the pathway, the user needs to be directed to clearly define the pathway in terms of origin, vector (e.g. person, commodity), transport mode (e.g. air, boat), destination, use of commodity and whether intentional or not to set the context for the pathway and enable a clearer assessment.
Assessments for organisms already present in the RAA don’t require a pathway analysis so a mechanism to bypass these questions (such as incorporating them all into an optional module as suggested above) is needed. Alternately, the NA option should be included in all pathway related questions.

**Probability of Establishment**

A number of climate matching software tools are available (e.g. CSIRO’s CLIMEX, USDA’s NAPPFAST or the Climate software freely available from the Bureau of Rural Science, [http://www.affashop.gov.au/product.asp?prodid=13506](http://www.affashop.gov.au/product.asp?prodid=13506)). The user could be directed to these as a means of quantifying the degree of climate suitability.

Many of the questions are unlikely to be well enough understood to warrant five levels of choice. To maintain overall structure the second and fourth options could be left out in such cases. Some of the questions could be combined. Comments in the annotated Excel template suggest where this might be done.

**Spread**

This involves just three questions, one of which we feel is more pertinent to the risk management stage. As noted above, these questions individually have a relatively large influence on the overall outcome. An option might be to merge them with the establishment section (since both relate to the likelihood component of risk) although we take the point that spread potential also determines the extent and speed of impact.

**Impacts**

A user of the system should be prompted to choose impact types from a list. Otherwise there is the potential to miss certain types of impacts through the user’s ignorance of these.

Not clear how the response to question 2.4 is to be used other than as general documentation as a prelude to Impact considerations. The same applies for question 2.20

As noted in the annotated Excel template, questions 2.7-2.10 are components of 2.6 and could be incorporated into the advice for that question. This would help balance the economic, environmental and social contributions to the overall impact assessment.

Note comments on Module 4 below.

**Other schemes**

The scheme is closely based on the EPPO scheme and adheres closely to the principles contained with ICPM 11. It also draws on the Australian and NZ Risk Management Standard and attempts to integrate weed risk assessment systems.
Published reports and papers that are relevant to the UKNNRA include


- Biosecurity Australia Import Risk Analysis (IRA) handbook (soon to be updated) and specific IRAs. http://www.daff.gov.au/PlantBiosecurity

- Pheloung WRA scheme:

Modules

Comment specific to the modules follow, in some cases reiterating comments made in relation to the main scheme.

Module 1 (Fish & Plant)

The outcomes from these modules are not really used in the risk assessment, aside from whether to consider them in the second stage. Seems not to be a great return on the effort involved just for a preliminary screening.

Benefits of using these instead of the Establishment, Spread, Impacts sections:
- Established system (for plants) used in other regions and testing has shown is best approach at present
- User friendliness and explicit prompting (e.g. of types of impacts)

Disadvantages of using these instead of the Establishment, Spread, Impacts sections:
- Are not generic at this stage (e.g. don’t apply to insects, microorganisms)
• Doesn’t fit with the general approach taken of separate scores for likelihood (entry, establishment, spread) and consequences (impacts) in determining an overall risk score
• Doesn’t capture uncertainties (aside from ‘don’t know’ responses)

Overall, the systems in module 1 don’t integrate well into the overall scheme as currently presented.

Recommendations
• Refer to as relatively independent systems to compare with outcome from UKNNRAS.
• Seek to ensure the risk factors in these systems included in the explanatory notes for the UKNNRAS questions – or list them (e.g. types of impacts, dispersal modes)

Module 2 (Pathway RA)

Need to clearly define the pathway (origin, commodity, mode of transport) – as in P2

Not really needed as a formal assessment process, just questions P1-P5 help clarify the pathways to be considered in the main module (and could possibly just be part of the main module). P6-P15 are redundant since already covered in the main module.

Alternatively, remove corresponding questions from the Main Module and use the output of the Pathway Module (multiple pathway assessments) to feed back into the Main Module for the risk of entry.

Need clear definitions for ‘low’, ‘medium’, ‘high’ for the questions, but not sure how these responses would be used.

Good to have a list of pathways to refer to. Additional pathways that should be included:
• Transported commodities needs many subheadings (e.g. fruit, grains, machinery) as this defines the pathway as much as how the commodity is transported to the UK
• Dried plant parts (herbs, nuts, flowers) under B Intentional Introductions which can have viable seeds.
• 3.5 is not needed – no different to 1.4

Module 3 (Receptor Risk RA)

This should be called ‘ENVIRONMENTAL RECEPTOR’ as it only deals with environmental impacts in the Main Module. A broader interpretation would be that a Receptor could be (e.g.) an agricultural industry or a particular region (of economic, environmental and social value), but this is not addressed in the module.

As with pathways, it is not clear how multiple receptors (e.g. for a region) would be assessed and combined into an integrated outcome.

Uncertainty does not appear to be assessed consistently in this module. In most cases, uncertainty will be high throughout the module because impacts will be hard to predict.
As currently worded, answers to many of the questions will default to high impact, since the questions refer to “any non-native organism”. Questions should refer to the single non-native organism being assessed to be useful.

Unclear how the scoring in the Module is to be interpreted to assist in answering the environmental impacts question 2.11.

Needs to be made much clearer and simpler to be useable. At present it will not function to prioritise vulnerability to biological invasion (in general) across receptors. It could be modified so that it does give relative vulnerability to a specific non-native organism.

Module 4 (Economic Impact)

Tables 1 and 2 are very useful in providing definitions to go with ratings (although scores range from 1-5 whereas scores in Main Module range from 0-4) and should be used in the Main Module scoring system.

Need to clearly reference where the tables were derived from (e.g. AS/NZS 4360 Risk Management) but the text explaining the table content is excessive.

The text and tables 3 and 4 on the fourth page are difficult to decipher and do not seem to have any bearing on the Main Module (e.g. what is the uncertainty referred to and what is justifiable?).

The Economic impact assessment template (page 51) is logical and easy to comprehend. There will be uncertainties, particularly in relation to years required to spread to maximum area at risk and in control costs (for species not in the country).

Overall, this module would be better renamed the ‘impact assessment module’ and needs to be simplified. With the exception of Table 2 (p. 49), pages 48-50 could be removed.

Module 5 (Summarising Risks & Uncertainties)

We prefer conditional probability as the scoring approach as it is better than simple summation in taking account of extreme values (i.e. very high or very low) and has been published (papers by Holt).

- Use of the Monte Carlo simulation is an effective way to integrate uncertainty into the final risk determination. However this hasn’t been properly implemented. While the user can use the recalculate function to gain some feel for the variation, the system should do this automatically for at least 100 iterations, accumulate the range of outcomes and display the appropriate probability distributions and statistics. This is necessary if any formal application of the uncertainty approach is to be made – e.g.: management is required if there is a greater than 5% chance of a medium or high outcome.

- Would prefer a triangular distribution rather than the uniform distribution for sampling from the range of scores – The way it is currently set up, the highest uncertainty effectively gives all options equal chance, which is no different from ignoring the question (the bounds of the
triangular distribution would need to be set up to extend one unit beyond the uncertainty range but note next point).

- The manual specifies that the extreme choices are the bounded limits, so the deviation from the selected option should stay within 0-4 (currently can get as high as 6 or as low as –2). This should be prevented either by employing an offset or truncation.
- The basis for choosing the probability conversion parameter (0.017) is unclear beyond the statement that it appeared to give the best results. We understand the basis for starting with an equivalent value for all questions (i.e. no weighting) but expect that some questions may eventually be deemed to require a relatively higher rating.
- Must ensure that all questions are independent and that there is a fair distribution of questions within a section (e.g. balance between number of economic, environmental and social impacts) and weighting between questions within a section (e.g. principal vs. subsidiary questions).
- The likelihood of being invasive prior to the assessment is assumed to be 50%. We believe there is sufficient historical evidence that the likelihood of an organism becoming invasive is much less than 50%. In the case of weeds, for example, 10% or less is a more realistic value (Williamson’s 10’s rule for example).

Risk is generally defined as the product (or combination) of likelihood and impacts. This could possibly be implemented more explicitly in the UKNNRA by combining entry, establishment and spread into a likelihood rating and then combining with impacts either using a 3x3 lookup matrix or converting the impacts into a numerical value ($$?) and calculating the product. The Monte Carlo simulation is applicable to either approach.

We understand that the terms of reference specified three risk categories. While this is sufficient for border decisions, if scheme is to be used for prioritisation, then 5 levels would be much more useful to rank species/pathways.

Module 6 (Risk Management)

The content of this section seems appropriate but by necessity is very generic. There may be some scope to present it in a simpler manner so users do not have to work their way through the questions. For example, a table format of possible measures for each of the four scenarios given on page 60 could be constructed (i.e. organism unintentional import, organism intentional import, commodity pathway, other pathways).

The system seems to incorporate the SPS Agreement principle of equivalence by identifying a range of possible measures that could be applied to manage the risk to an acceptable level. The process could be more clearly prescribed by specifying that the risk assessment be redone with measures taken into consideration to determine if the risk is reduced to an acceptable level. Question 3.33 possibly suggests that economic benefits of trade could offset the risk. This would be counter to SPS principles. The second sentence of the question should be reworded or discarded. If the risk is unacceptable, then measures should be imposed regardless of the trade benefits.

For some questions, there is no ‘If no’ option (e.g. 3.5, 3.6) and the implication is that the user just proceed to the next question – this could perhaps be made explicit.
Q 3.17 suggest change “accepted without risk” to “received with acceptable risk”.

Consideration of the mobility of non-native species, page 64: Assumes that glasshouse production may easily contain highly mobile invasive non-native species. The escape of bumblebees in the UK from glasshouses suggests this is most unlikely.
Informal comments from fourth Peer reviewer:

1. The wider system/policy base clearly needs clarification, it would be useful to have some discussion around the identified reasons for performing a risk assessment (organism, pathway, receptor, policy change) and how each of these relate to international and national legislative requirements. It is difficult to determine whether a scheme is 'fit for purpose' without an understanding of the purpose. For instance is the terminology is appropriate? 'Invasive' seems to be an important attribute which appears to mean is likely to have adverse environmental consequences. Other interesting terminology is 'ordinarily resident' 'Organism screening' seems to be similar to the process of hazard identification. 'Regulated species' are mentioned in para 3.4.1of the risk management module but not included in the glossary or their significance explained.

2. A structured framework is helpful as an aide memoire but can be restrictive, and result in things being missed or the assessment being prematurely terminated. This may be particularly the case for hitchhiker organisms. For instance step 17 of the organism assessment relates to speed of spread. If a judgment is made that an organism cannot spread rapidly the assessment can be terminated before a detailed assessment is made.

3. Uses a semi-quantitative approach - thus there is evaluation of the probability of entry and establishment, and yet assessment of possible economic, environmental and social impacts. The boundaries between the five likelihood categories are not explained (although guidance is given for the economic impact steps) and when assigned scores may give misleading results. This is likely to be a particular issue if there is limited data available, as I imagine will be the case for hitchhikers and many environmental pests. The use of scores is about risk communication and there are other perhaps more effective approaches to this. The approach may be particularly misleading in the impact assessment section - there are 6 questions to be scored on direct economic impacts, but only 2 on environmental harm and 2 on social impacts.

4. A potential flaw is the importance attached to whether an organism has entered and established viable populations in new areas outside its original range. If it hasn't, the assessment can be concluded on the basis that it is unlikely to be a harmful organism (steps 16 and 20 of organism risk assessment). Step 20 has a caveat that you may want to continue the assessment or seek a second opinion but the guidance is to stop. New Zealand if very different from Britain in terms of the high levels of endemic flora and fauna, so the response of exotic organisms might be expected to be different in New Zealand. Nonetheless there are examples of incursions of species (e.g. painted apple moth) that had not previously established outside their natural range that could be ruled out of further assessment by this approach.

5. Identification of pathways - whilst detection records are indeed a useful indicator of an organisms ability to be associated with a pathway, the extent of their usefulness will depend on the details of the detection, identification and recording systems. From our experience, it is important that the limitations of such data are understood.

6. Receptor risk assessment module. The description of impacts of non-native organisms in step R9 is simplistic and potentially misleading. Adding an additional species to a habitat will undoubtedly increase its diversity at least in the short term. It may also increase the extent
of a particular habitat if the new species is able to spread rapidly. However neither of these factors are necessarily beneficial to the habitat. Diversity and extent are not the only indicators of habitat quality. This step would be more helpful if it seeks to identify the range of values associated with a habitat (perhaps using English Nature’s Valuing nature framework) and assess impact on these. This is a particularly difficult part of the assessment process

7. Risk management scheme module. This correctly identifies the key issue of determining whether the identified risk is acceptable. This is one of the biggest challenges for us. There does not appear to be any guidance on how this judgment is reached nor on whether identification of another lower level of risk should be identified for the purposes of risk management measures. An important but difficult aspect of risk management is linking specified risk management measures to the identified level of risk and associated risk management objective. The measures in this module appear to be mainly quarantine measures rather than eradication or pest management measures. Different issues will need to be considered depending on the purpose of risk analysis.
APPENDIX 2 – Comments of peer reviewers for modules not relating to organisms and pathways
Module 3 – Receptor Risk RA

- The term receptor is not understood so the term “Environmental Receptor” is suggested as a replacement.

- It was not clear how the many outputs would feed into the main outputs of the risk assessment scheme, for example does the module assist in answering 2.11?

- Uncertainty is not consistently assessed in this module but uncertainty is likely to be high throughout as impacts are difficult to predict.

- Currently, answers would default to high impact as questions refer to “any non-native organism”.

- Needs to be made much clearer and simpler to be useable.

- At present it will not function to prioritise vulnerability to biological invasion.

- It is not clear how the system deals with multiple receptors / habitats.

- R2,3 refer to the UK – should this be ‘Risk management area’?

- R7 should read “If the receptor is one or more habitats…”

- R9 – Is impact considered one invasive species at a time or all together?

- What defines ‘widespread’ in this module?

- R12 – the wording should also be used for R9.

Module 4 – Economic Impact

- Different interpretation needs to be considered for eradication compared to control.

- The text and tables within the explanation for this module are excessive and, at times, difficult to decipher however Tables 1 and 2 are useful and should be used in the main module.

- Sources of tables should be referenced.

- Economic impact assessment template (page 51 of user manual) is logical and easy to comprehend however there will be uncertainties associated with this.

- Module could be renamed “Impact Assessment” module.

- Responses costs should be separated from monetary loss.

- It is not clear if monetary loss includes health, environmental and social/cultural impacts converted into $.
Module 6 – Risk Management Scheme

- Content of this section is generic but this is out of necessity – it could be modified to make it simpler by reducing the number of questions to be completed.

- Justification of responses should be applied to this module as it is in the main risk assessment module.

- Mobility of invasive species is not considered in the module as it suggests glasshouses could contain species – not the case for species such as bumblebees.

- Other considerations than reliability should be taken into consideration, for example where eradication is an option.

- With some questions, the process to follow when answering questions is only implied and should be made clearer.

- SPS Agreement principles are incorporated then countered by the suggestion that economic benefits of trade can offset the risks posed.

- Q3.17 – suggested alteration from “accepted without risk” to “received with acceptable risk.”
APPENDIX 3 – Co-ordinator’s questionnaire for risk assessors
Questionnaire for Scottish Executive non-native risk assessment scheme:

The questionnaire is split into 4 sections relating to different areas we would like to assess. Please answer the questions in each section to the best of your abilities. Feel free to make notes prompted by the questions, or other comments. We are keen to achieve an insight into how well the risk assessment process works in terms of both ease of use and relevance of outputs.

Thank you.

**Section 1 – General information**

1.1. What is your interest in the assessed species?

1.2. Does your work involve the assessed species? If so, how?

1.3. Do you have experience in assessing the risks of non-native species?

1.4. It is possible that the opinions of the risk assessor may have a biasing effect on the outcome of the risk assessment. Do you have a non-neutral approach to this issue? If so please indicate how.

1.5. Please indicate the range of your UK experience of the species.

   England, Scotland, Wales, St. Helena, West Indies, etc.
Section 2 – Overall impression

2.1.  Please provide a statement indicating your overall impression of the risk assessment.
Section 3 – Ease of use

3.1 Please select the response that mostly closely reflects your opinion of the risk assessment scheme.

The risk assessment was easy to use.
- agree strongly
- agree
- disagree
- disagree strongly

3.2 How long did it take you to complete the risk assessment (in person hours)?

3.3 How long did you anticipate it would take to complete the risk assessment (in person hours)?

3.4 Did you complete the risk assessment alone, or did you consult others? If so, indicate how many others and the proportion of time in person hours put in by each.

3.5 Did you find the electronic format of the risk assessment easy to use?

3.6 Did the questions make it clear what was required in the response? If not, please give examples.

3.7 Are the terms used clear and unambiguous? If not, please give examples.

3.8 Do the pre-defined responses, e.g. not likely, less likely, more likely, very likely, provide a complete set of relevant possibilities?

3.9 Was the user guide clear and useful? If not please give indicate how and give examples where relevant.

3.10 What additional information / advice were you provided with that you found helpful to complete the risk assessment?

3.11 How would you improve the ease of use of the risk assessment?

3.12 Please outline your approach to using the categories provided as standard responses (e.g. likely, moderately likely, moderately unlikely). Where possible give 3 examples of questions where an answer like this has been given and indicate how these answers were derived.

3.13 Which sections, or questions, took the longest to provide suitable answers? What element of the risk assessment was the most difficult and most time consuming?
Section 4 – Value of the output

A. Assessing whether a species is a risk

4.1 In your opinion, did the risk assessment correctly identify the species as a risk (or not) in the risk assessment area? If not, explain what discrepancies there are.

4.2 Are there any questions that make the identification of the species as a risk ambiguous? If so, please give examples.

B. Assessing what the risks are and their impact

4.3 In your opinion, does the risk assessment identify relevant risks?

4.4 Are all the relevant risks identified? If not, please give examples

4.5 Is appropriate weighting given to each of the risks? If not, please give examples

4.6 Did the risk assessment take into account all of the relevant features of the species you feel are important for the assessment? If not, please give examples

4.7 Does the risk assessment identify relevant pathways used by the species? If not, please give examples

4.8 Does the risk assessment identify relevant impacts of the species? If not, please give examples

And finally

4.9 Please select the response that mostly closely reflect your opinion of the risk assessment scheme:

The risk assessment appropriately identifies the risks of the subject non-native species.

- agree strongly
- agree
- disagree
- disagree strongly

4.10 What improvements would you like to see made to the risk assessment?
APPENDIX 4 – List of terms requiring a clear definition

The following terms were identified by the co-ordinating team, risk assessors or peer reviewers as examples of those that need further clarification. These were found in the risk assessment template (Module 5) or in the User Manual. In some cases definitions are provided the term, however these were found to be confusing.

The term is listed, followed by the question number (if in Module 5 of the risk assessment) or page number (if in the User Manual):

- Invasive non native species (Glossary of User Manual)
- Present range (Qu 7 Section A; User Manual page 14)
- Effective containment (Qu 9 Section A; User Manual page 14)
- Widely distributed (Qu 10 Section A; User Manual page 15)
- Original range (Qu 16 Section A)
- Concentration (Qu 1.4 Section B; User Manual page 19)
- Volume (Qu 1.9 Section B; User Manual page 20)
- Concentration of the organism on the pathway (Qu 1.4 Section B)
- Current distribution (Qu. 1.15 Section B)
- Present distribution (Qu 1.16 Section B)
APPENDIX 5 – Papers recommended for consideration by the peer reviewers and other sources


Biosecurity Australia Import Risk Analysis (IRA) handbook (soon to be updated) and specific IRAs. http://www.daff.gov.au/PlantBiosecurity


Hayes KR and Barry SC (in revision) Are there any consistent predictors of invasion success?


GRASP http://cat.inist.fr/?aModele=afficheN&cpsidt=14361739

Climex www.csiro.au/csiro/content/standard/ps1h3,,.html


Figure 6. Organisation chart showing suggested working stages in the NNRA development
Pest risk analysis

Need to assess risk of non-native species

EPPO

Defra Review of the Working Group

Consortium

UKNNRA

Trialling and Review Project

Practicalities of using and running the scheme

Assessment of the scoring system

Content and scope

Recommendations

Further development

Implementation of NNRA

Training and Education

Receptor Risk Assessment Module

Risk Management Module

Central Meta-database / Continued development

UK

OTs

Pheloung et al

Copp et al