



Best Practices in **Pre-Import Risk Screening** for Species of Live Animals in International Trade

*'Proceedings of an Expert Workshop on Preventing Biological Invasions:
Best Practices in Pre-Import Risk Screening for Species of
Live Animals in International Trade, University of Notre
Dame, Indiana, USA, 9-11 April 2008'*

Edited by Sarah Simons & Maj De Poorter



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Global Invasive Species Programme

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Global Invasive Species Programme

The Global Invasive Species Programme

(GISP) is an international partnership dedicated to tackling the global threats of invasive species through policy development, awareness raising and information exchange.

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This publication constitutes the Proceedings of an Expert Workshop on Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade, which was held at the University of Notre Dame, USA, 9-11 April 2008. The workshop was organised by the Global Invasive species Programme (GISP), the Invasive Species Specialist Group (ISSG) of the Species Survival Commission of IUCN and the Secretariat of the Convention on Biological Diversity (SCBD), in collaboration with the University of Notre Dame and Defenders of Wildlife. Co-sponsorship was provided by Australia's Department of the Environment, Water, Heritage and the Arts; North American Free Trade Agreement, Commission on Environmental Cooperation; National Wildlife Federation; Natural Resources Defense Council; Pet Industry Joint Advisory Council; The Nature Conservancy; and the Union of Concerned Scientists, with additional support provided by U.S. Geological Survey, Invasive Species Program, U.S.A and the National Biological Information Infrastructure.

The content contained herein is based on the Final Rapporteur's Report of the Expert Workshop which was prepared by Maj De Poorter and Michael Browne (both of ISSG, a specialist group of IUCN's Species Survival Commission (SSC)) and David Lodge (University of Notre Dame), with major contributions from Junko Shimura (SCBD), Peter Jenkins (Defenders of Wildlife) and Stas Burgiel (GISP). GISP would also like to acknowledge the support of Peter Jenkins for facilitating the entire process including the contractual aspects; David Lodge and Joanna McNulty (University of Notre Dame) for hosting and organising the workshop; Phyllis Windle (Union of Concerned Scientists) and Heidi Ruffler (Defenders of Wildlife) for assisting as rapporteurs; and finally, thanks to all participants for their often extensive and thoughtful comments.

Acronyms & Terminology (used in the Proceedings)

CBD = Convention on Biological Diversity.
 CITES = Convention on International Trade in Endangered Species.
 COP = Conference of the Parties.
 GIS = Geographic Information System
 GISP = Global Invasive Species Programme.
 IAS = invasive alien species (= alien invasive species).
 ICES = International Council for the Exploration of the Sea.
 IMO = International Maritime Organization.
 IPPC = International Plant Protection Convention.
 ISSG = Invasive Species Specialist Group of IUCN's Species Survival Commission.

IUCN = International Union for the Conservation of Nature.
 OIE = World Organization for Animal Health.
 SBSTTA = Subsidiary Body on Scientific, Technical and Technological Advice (of the CBD).
 SCBD = Secretariat of the Convention on Biological Diversity.
 SPC = Secretariat of the Pacific Community.
 SPS = Agreement on the Application of Sanitary and Phytosanitary Measures (of the WTO).
 UNEP = United Nations Environment Programme.
 WRA = Weed Risk Assessment.
 WTO = World Trade Organization.

Screening: "A systematic examination or assessment, done especially to detect an unwanted substance or attribute." Here it refers to risk assessment in the context of biological invasion risks.

Risk assessment is used extensively in the technical literature on invasive alien species and many other issues involving decisions about environmental pollutants. This includes the World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Measures (WTO SPS Agreement), in which "risk assessment" is defined, in pertinent part, as: "The evaluation of the likelihood of entry, establishment or spread of a pest or disease within the territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences."

Introduction: the movement by human agency, indirect or direct, of an alien species outside of its natural range (past or present), in accordance with the Convention on Biological Diversity (CBD) although it should be noted that this differs from other definitions e.g. that of the IPPC.

Import: the bringing of a species into a country from another country (usually, in this context, as part of international trade).
 Note: "introduction" (see above) refers to the movement of a species across an ecological boundary but "import" refers to the movement across a jurisdictional boundary.

Technical capacity: the competency of conducting risk assessment (see above) on alien species in accordance with the standards of existing international regulatory frameworks and other voluntary codes. This includes the availability and reliability of data to use for the risk assessment and legal competency to apply the result of risk assessment in management to address invasive alien species (including decision-making and management of risks).

Executive Summary

Trade in live animals is responsible for the movement of large numbers and volumes of animal species around the world. It is also a major contributing factor in invasions by non-native species, including the spread of animal and human diseases globally. Invasive species are widely considered to be the second most important factor in the loss of biological diversity globally. Whereas international standards exist for the pathways of most potentially invasive species, such as the live plant trade, release of ballast water from ships, and livestock pathogens; with the limited exception of those animals that are covered under the International Plant Protection Convention as pests of plants, there is an absence of international standards addressing invasive animals.

These findings emerged in 2005, following an Ad Hoc Technical Expert Group (AHTEG) meeting on, 'Gaps and Inconsistencies in the International Regulatory Framework in Relation to Invasive Alien Species' convened by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the Convention on Biological Diversity (CBD). The AHTEG reported a significant general gap in the international regulatory framework concerning the lack of standards to address animals that are invasive alien species, and further identified subsets of this issue i.e. alien species in aquaculture and introduced pets, which were not covered by existing international standards. The CBD subsequently endorsed the AHTEG's findings in 2006 at the 8th Conference of the Parties (COP8) and urged Parties and other Governments to take measures, as appropriate (decision VIII/27).

One of the agenda items scheduled for the 9th Conference of the Parties (COP9) of the CBD in May 2008, was an in-depth review of ongoing work on alien species that threaten ecosystems, habitats or species, including gaps and inconsistencies in the international legal framework identified by COP8. In preparation for COP9, an expert workshop was organised entitled, 'Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade', held at the University of Notre Dame in South Bend, Indiana, United States of America (USA), from 9th to 11th April 2008. The workshop was organised by the Global Invasive species Programme (GISP), the Invasive Species Specialist Group (ISSG) of the Species Survival Commission of IUCN and the Secretariat of the Convention on Biological Diversity (SCBD), in collaboration with the University of Notre Dame and Defenders of Wildlife. Preliminary findings of the workshop were summarised in an information paper to CBD COP9 [UNEP/CBD/COP/9/INF/32/Add.1] as a contribution to the in-depth review of ongoing work on alien species,

and subsequently, a Rapporteurs Final Report was produced. The present publication constitutes the Proceedings of the aforementioned workshop, which focused on 'best practices' to address the risks associated with imports of live animals (and their parasites and pathogens) in international trade. Such species are imported primarily for the pet, aquarium/terrarium, aquaculture/mariculture, live bait, game farming, fur farming and live food industries, and include terrestrial, aquatic, vertebrate and invertebrate species. The publication aims to assist with implementing CBD Decision IX/4 by ensuring that the information contained herein is widely available through the CBD clearing-house mechanism as well as to the 10th SBSTTA of the CBD for its consideration at its meeting prior to the 10th CBD COP.

Participants at the expert workshop on preventing biological invasions: best practices in pre-import risk screening for species of live animals in international trade, considered the issues under eight key themes as follows: i. Risk assessment and decision-making; ii. Progression of biological invasion and risk assessment approach; iii. Concepts and technical tools for risk assessment of live animal species; iv. Gaps in the international regulatory framework; v. National implementation, strategic approaches, capacity; vi. Sub-national and regional risk assessments; vii. Awareness and stakeholder involvement; and viii. Information requirements and sharing. For each theme, the main conclusions are presented, followed by additional notes in support of the conclusions and recommendations.

Extensive discussions held during the course of the workshop, resulted in broad agreement on a suggested risk assessment approach for the importation of live alien animal species (and their parasites or pathogens). The approach is not intended to be applied as an 'off the shelf' risk assessment framework but aims to provide generalised guidance. Essentially, it is a "proof of concept" that can be developed further over time. It is anticipated that the proposed risk assessment approach will assist countries or industries in developing or revising their own risk assessment procedures in the context of live alien animal imports. A set of questions is proposed as an integral part of the risk assessment. These can be adapted and formalized so that the risk assessment approach is appropriate to country-specific legal authorities, industry-specific needs, data availability, technical capacities, and available resources, while noting that risk assessment is an evolving methodology that is being improved and revised continuously.

Foreword

Message from Dr. Ahmed Djoghlaif, Executive Secretary of the Convention on Biological Diversity on the occasion of the

Expert Workshop on Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade University of Notre Dame, Indiana, USA, 9-11 April 2008.

The global live animal trade is constantly moving large volumes of thousands of different animal species around the world. This trade contributes to non-native species invasions, a phenomenon cumulatively considered to be a serious factor in the global loss of native biological diversity. Disease risks to humans, domesticated animals and wild animals may be associated with the live animal trade as well. The cost that the world pays for the loss of biodiversity is on the scale of billions of dollars every year – and this only accounts for the known cases. Moreover, this estimate increases when one takes into account the cost of eradication of invasive alien species (IAS) and mitigation of the impacts that they have on endemic species. Clearly, the risks of invasive alien species are substantial. If we are to address these risks, precautionary measures must be considered. If we are to meet the 2010 Biodiversity Target, the spread of IAS must be mitigated.

Thus, it is with great pleasure that I send my greetings to the distinguished participants of the expert workshop, Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade. The importance of such a workshop is undeniable and indeed, public awareness of these issues needs to be increased. The Secretariat of the Convention on Biological Diversity (CBD), together with the Global Invasive Species Programme (GISP) and the Invasive Species Specialist Group (ISSG) of IUCN's Species Survival Commission as sponsors of this workshop, are working hard to bring the issues of IAS to the fore. I commend the efforts of GISP, ISSG, and my own Secretariat staff colleagues, who also have been ably assisted by the University of Notre Dame, the generous host of this workshop, and by Defenders of Wildlife, a U.S. NGO assisting with planning and organisation.

The organisers have gathered a top-notch line-up of global expertise on addressing the risks of the international live animal trade. The fascinating topics range from the key biological features of various animal species in risk analysis to economic cost-benefit analysis of pre-import risk screening, and from the role of global information collections to the provisions of international law that may apply.

This workshop responds to a decision from the CBD's eighth Conference of the Parties that highlights the lack of international guidance for addressing potential risks of international trade in animals that are not plant pests, i.e. species used in aquaculture/mariculture, pets, aquarium and live bait species, and similar animals. I note this is the first global workshop to broadly consider international practices and tools for risk screening for potentially invasive animals. Some of these practices and tools are currently being implemented, while others remain under development. Moreover, there is a wide variance in national capacities and priorities on this issue. As such, this workshop is key to mobilizing networks to provide guidance, support, as well as capacity building, and to prevent, mitigate, and address devastating impacts from IAS.

Two months ago, the thirteenth meeting of the CBD's Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-13) considered the question of international standards that may or may not apply to the live animal trade. A recommendation resulting from SBSTTA-13 specifically highlighted the importance of this workshop. Additionally, this recommendation will be considered during the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP9), which will be held in Bonn, Germany, from 19-30 May, 2008.

Your workshop can play an important role in advancing the CBD's cross cutting issue on invasive alien animal species. I encourage the workshop participants to strive together to enhance international knowledge, information sharing, and capacity in this area. I note and welcome the fact that summarized results of your workshop will be provided to the CBD's in depth review of its work on invasive alien species at COP9 in May, which is little more than one month off.

I finally gratefully note that several organisations and governments have provided funding to support the participation of as many experts as possible. Indeed, many of the CBD's efforts are dramatically strengthened by generous co-sponsors and contributors to such jointly-organized workshops.

I therefore welcome this workshop as a significant aid to the implementation of the CBD programme of work on invasive alien species. I wish you a fruitful meeting and look forward to reading the full report on its outcome.

Rationale

Trade in live animals is responsible for the movement of large numbers and volumes of animal species around the world. It is also a major contributing factor in invasions by non-native species, including the spread of animal and human diseases globally. Invasive species are widely considered to be the second most important factor in the loss of biological diversity globally.

In 2005, the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the Convention on Biological Diversity (CBD) convened an Ad Hoc Technical Expert Group (AHTEG) meeting on, 'Gaps and Inconsistencies in the International Regulatory Framework in Relation to Invasive Alien Species'. Paragraph 21 of the report from the AHTEG meeting, states.

'A significant general gap in the international regulatory framework relates to lack of international standards to address animals that are invasive alien species but are not pests of plants under the International Plant Protection Convention [IPPC]..'

International standards exist for the pathways of most invasive species, such as the live plant trade, release of ballast water from ships, and livestock pathogens but with the limited exception of those animals that are IPPC-covered plant pests, the AHTEG reported an absence of standards addressing invasive animals.

The AHTEG report further identified the following subsets of this issue:

- (i) Alien species in aquaculture (freshwater and marine, as well as land-based systems), including deliberate introduction of cultured species themselves, hitchhikers on cultured species or equipment and goods and associated disease organisms not covered by the World Organization for Animal Health (OIE). NB: some fish and shellfish diseases are covered by (OIE) [paragraph 55 of the AHTEG report].
- (ii) Introduced pets, including aquarium species, such as fish, reptiles, or insects, and live bait and live food that can become invasive [paragraph 86 of the AHTEG report].

In 2006, the 8th Conference of Parties (COP8) of the CBD endorsed the AHTEG's findings of an "invasive animal gap". Of particularly relevance is paragraph 53 in the COP's decision VIII/27, which states, 'Urges Parties and other Governments to take measures, as appropriate and consistent with their national and international obligations, to control import or export of pets, aquarium species, live bait, live food or plant seeds, that pose risks as invasive alien species;...'

At the 9th Conference of the Parties (COP9) of the CBD in May 2008, one of the agenda items scheduled was an in-depth review of ongoing work on alien species that threaten ecosystems, habitats or species, including gaps and inconsistencies in the international legal framework identified by COP8. In preparation for COP9, an expert workshop was organised entitled, 'Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade', held at the University of Notre Dame in South Bend, Indiana, United States of America (USA), from 9th to 11th April 2008.

Preliminary findings of the workshop were summarised in an information paper to CBD COP9 [UNEP/CBD/COP/9/INF/32/Add.1] as a contribution to the in-depth review of ongoing work on alien species. The present publication, the Proceedings of the aforementioned workshop, focuses on 'best practices' to address the risks associated with imports of live animals (and their parasites and pathogens) in international trade. Such species are imported primarily for the pet, aquarium/terrarium, aquaculture/mariculture, live bait, game farming, fur farming and live food industries, and include terrestrial, aquatic, vertebrate and invertebrate species. It is important to note that, non-native animals together with their parasites and pathogens, are introduced into countries both unintentionally and intentionally, but that the workshop focused on addressing the risks associated with intentional introductions of live animals.

This publication aims to assist with implementing the Decision IX/4 from COP9 specifically paragraph 9 which states, 'Requests the Executive Secretary, in collaboration with the Global Invasive Species Programme (GISP), the IUCN Invasive Species Specialist Group (IUCN-ISSG), the International Civil Aviation Organization, the Pet Industry Joint Advisory Council and other relevant organizations to continue collating, the information provided on the basis of paragraph 8, as well as the information gathered at the expert workshop on best practices for pre-import screening of live animals (UNEP/CBD/COP/9/INF/32/Add.1, held in Indiana, United States of America from 9 to 11 April 2008 and organized by the Global Invasive Species Programme, the Invasive Species Specialist Group and the University of Notre Dame, in collaboration with the Secretariat of the Convention on Biological Diversity, best practices for addressing the risks associated with the introduction of alien species as pets, aquarium and terrarium species, and as live bait and live food, and to make this information available through the clearing-house mechanism as well as to the Subsidiary Body on Scientific, Technical and Technological Advice for its consideration at a meeting prior to the tenth meeting of the Conference of the Parties;...'

Main conclusions

Workshop participants took part in their individual expert capacity. While the conclusions and suggestions reflect overall broad agreement, they are not meant to imply consensus by every participant. Conclusions and suggestions do not necessarily represent the views of any individual participant nor of their employer (institution/agency), nor of sponsors, contributors or the host institution. Proceedings at the Expert Workshop on Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade, were considered under eight key themes are follows:

- i. Risk assessment and decision-making.
- ii. Progression of biological invasion and risk assessment approach.
- iii. Concepts and technical tools for risk assessment of live animal species.
- iv. Gaps in the international regulatory framework.
- v. National implementation, strategic approaches, capacity.
- vi. Sub-national and regional risk assessments.
- vii. Awareness and stakeholder involvement.
- viii. Information requirements and sharing.

For each of these themes, we present the main conclusions followed by additional notes in support of the conclusions and recommendations.

1. Risk assessment and decision-making

The workshop strongly endorsed the need for conducting science-based risk assessments, appropriate to the specific context, before decisions concerning the proposed importation of live, non-native animal species into a country can be made. The assessment should include biodiversity and environmental risks associated with the non-native species, together with their associated parasites and pathogens.

It was further agreed that the best risk assessment procedures are:

- science-based
- transparent
- comparable and repeatable
- based on reliable data
- conducted using the best information available
- designed to consider uncertainties explicitly

In general, science-based quantitative tools are considered to be the most effective although qualitative tools can serve supplementary and/or complementary purposes and may be all that is available under certain circumstances. Due to lack of capacity, it may be necessary to make decisions using risk assessments based on limited data and information. Thus, the need for capacity-building in risk assessment was identified as a top priority (see also section (5) below).

The workshop also noted that the actual decision concerning whether or not a specific non-native species could be imported (and under what conditions, if any) is not a part of the risk assessment although the risk assessment is used as the basis for a decision by a relevant authority. In this context, assessment of the risks to biodiversity and the environment is an important input to decision-making. Decision-makers may have to consider additional matters such as national policy, food security, livelihoods and cost-benefit considerations.

Additional notes on risk assessment and decision-making

In general, risk assessment should:

- ensure differentiation between situations with different risks, such as different locations of origin, different pathways, different end uses proposed for the species.
- be based on real risks and not perceived ones (e.g. some people may have a bias against snakes regardless of their likely or real impacts).

In terms of decision-making:

- Decision-making systems usually include the option of allowing import either with no or few conditions or with stringent conditions as well as the option of not allowing import (see box).
- Decisions based on risk-assessment procedures could be part of a country's regulatory framework or part of a self-regulating process - for example an industry code of conduct.
- How to include precaution in decision-making is a policy question, open to a range of choices.
- Making a decision about species that are assessed as 'medium' risk is a particular challenge (as opposed to species that are assessed as high or low risk, in which case decision-making is often more straight forward). Such species could, for example, have a lag phase before becoming invasive, which might be cause for rejection; or they could be minor risk species that will not become invasive.
- Cost/benefit considerations may include impacts of substitutes (if a species is not allowed), human well-being, biosecurity concerns, sustainable use and livelihoods.
- Decision making should be independent of proponents of the import.

Case study: Decision-making - conditions for holding species

- i. Where species are assessed as, 'likely to be benign', importation could usually be allowed with few, if any, conditions.
- ii. Where species are assessed as, 'likely to pose a high risk of harm', could be prohibited or, if import is allowed, be subjected to stringent conditions (such as sterilization) to manage identified risks.

Different countries have developed different types of conditions, suitable to their circumstances. For instance: in Israel the decision may put restrictions on what type of people/entity can hold the species (e.g. zoo, research facility, collector, general public, etc) whereas in the Australian system, the decision may specify containment requirements for holding the species.

2. Progression of biological invasion and risk assessment approach

For risk assessment approaches to be effective, they need to take into account the progression of a biological invasion from importation to release (or escape) into the environment, establishment, spread and impact. This does not imply that impact only occurs after establishment and spread has taken place – even if an alien species does not become established it can still impact biodiversity. Ideally, this approach includes assigning probabilities to each step.

The workshop proposed a risk assessment approach for the importation of live alien animal species (and their parasites or pathogens) (Table 1), which is based on the common set of risk assessment questions and approaches now used successfully in many countries. The approach is also consistent with international risk assessment frameworks developed for other purposes such as the IPPC, World Trade Organisation Sanitary and Phytosanitary Measures (WTO SPS) Agreement, OIE, and the International Council for the Exploration of the Sea (ICES).

It is intended that the approach proposed should provide generalised guidance – it is not intended to be applied “off the shelf” as a risk assessment framework. The approach as shown in Table 1 is essentially a ‘proof of concept’, which can be developed further over time.

It should be noted that risk assessment is an evolving methodology that is being improved and revised continuously.

Additional notes on Progression of biological invasion and risk assessment approach

In the context of importation and likelihood of release (or escape), the following should be considered:

- Different pathways of intentional introductions (for example aquarium fish versus aquaculture species) will usually have different probabilities of release/escape.
- Different intended uses may be associated with different probabilities of escape and/or release.
- The origin of animals intended for import may have a significant effect on the likelihood of them carrying parasites/diseases.

Case study: Captive bred versus wild caught animals

There may be differences between captive bred and wild-caught animals of the same species that need to be taken into account in any particular risk assessment. A consensus on whether captive bred animals could be considered to present less of a risk due to a lower parasite/pathogen load was not reached; some were of the opinion that importing captive bred animals would be a way forward to significantly reduce risks in the live animal trade, whereas others were of the opinion that a lower parasite load in species traded at high volumes nevertheless represents a significant risk factor.

It was pointed out that captive breeding of non-native species in the country of import (e.g. of ornamental fish) should be included in the risk assessment because it increases propagule pressure and many species have a high risk of release and escape. On the other hand, there are many instances of the industry improving biosecurity in more recent installations and engaging in user-education with the aim of reducing release / escape.

There was some discussion on whether reducing the wild-caught animal trade could have undesirable ramifications for livelihoods and conservation in exporting countries. Some expressed concern that there would be a loss of incentive to protect native habitats/sites if sustainable use of native wildlife for export was reduced.

Note: Some countries e.g. Israel accept only captive-bred animals for import, even for zoos.

In terms of predicting the likelihood of establishment:

- Various tools/techniques exist for climate-matching and while in any particular circumstances one may work better than another, overall there is a good degree of confidence in all the commonly used ones.
- For any particular circumstances (species X and country Y), a range of factors can be related to risk, including animal behaviour (e.g. reproductive strategy, demography, niche, etc.), biology (e.g. fecundity for molluscs in the Great Lakes, USA) and biotic interaction. For general and wide use, however, only climate match, history of invasiveness i.e. ‘invasiveness elsewhere’ and number/size of releases (propagule pressure) tend to be consistently related to establishment success.
- A challenge for climate-matching tools will be to successfully incorporate future climate change.
- When applying a tool for climate matching, the appropriate native range to use is not necessarily that of the “species” as a whole - it may be that of a particular subspecies or population.

In terms of predicting the likelihood of spread:

- Many successful models for spread exist.
- Natural dispersal and human mediated dispersal should both be considered when carrying out a risk assessment.
- Some alien species do not require establishment or spread in order to have an impact on native biodiversity.

In terms of predicting the likelihood of invasiveness (impact/hazard):

- Likelihood of impact and consequence (nature) of the impact are both important in risk assessment
- Several approaches can predict invasiveness accurately, but no approach is perfect
- Challenges include:
 - o ‘Invasiveness elsewhere’ is a key factor in risk assessment – but use of the term “invasive” is not standardized
 - o Evaluating animals below the species level, e.g., hybrids, breeds, (strains for plants, diseases), subspecies, biotypes
 - o Gathering a list of all invasive species
 - o Gathering a list of all taxa in trade.

In considering the economics of risk assessment:

- Economic assessment involves measuring the benefits of import minus the costs of invasion and the costs of screening.
- Challenges include:
 - o The costs to biological diversity are largely incalculable
 - o Measuring the economic impacts of invasive species and invasions requires a lot of data, which is not always available, even for species in their native ranges.

Case study: economic benefits of risk assessment

Many participants were of the opinion that by applying risk assessment and decision-making to live imports, not only can invasiveness risks be reduced but the net economic value of international trade in live animals can likely be increased. It was for instance, pointed out that for plants, screening tools are, generally speaking, sufficiently accurate in their assessment to inform decision-making. In the case of Australia’s ornamental plant trade, modelling has shown that screening tools are

sufficiently accurate to produce economic benefits (screening paid for itself in a relatively short time).

Some participants were of the opinion that for animals, economic benefits would likely be even greater because a larger proportion are estimated to become invasive, while other participants were of the opinion that such a conclusion is still very speculative at the moment.

3. Concepts and technical tools for risk assessment of live animal species

Substantial progress has occurred recently in the development of concepts and technical tools for risk assessment of live animal species proposed for importation. A number of presentations demonstrated that it is now often possible to distinguish, with acceptable levels of accuracy, between non-native species that will probably be harmful to the importing country and non-native species that will probably be benign. These concepts and tools were built by combining recent progress in the discipline of invasion biology with standard practices in the more established discipline of risk assessment.

Traits predictive of establishment risk or invasiveness risk vary among taxa and this has ramifications for the development of risk-assessment tools. The workshop noted that various tools (qualitative as well as quantitative) for use in risk assessment have been developed and adapted, and that their successful application has been demonstrated in a range of countries (although not for all geographical areas nor all taxa). Some of these tools have already been made publicly available by those that developed them (a partial list is provided in the appendix).

The workshop suggested that tools used as part of the risk-assessment process be clear, consistent, fit for the specific purpose, and effectively utilize available information. Ideally these tools draw on the best available information and are applied in a transparent and accountable manner. It was noted that in general, science-based quantitative tools will achieve this best, but that until such time as these can be applied effectively, non-quantitative tools can serve supplementary and/or complementary purposes and may be all that is available under certain circumstances.

Additional notes on concepts and technical tools for risk assessment of live animal species

- Trait-based prediction tools e.g. using biological characteristics of the alien species such as tolerance for water temperature and salinity, size at maturity and reproductive rates) can work well in specific circumstances - for alien fish in the Great Lakes ~90% accuracy was obtained with a simple decision tree based on such traits.
- 'Invasiveness elsewhere' (also called 'Invasion history') is a key factor used in many prediction tools.
- There are established tools for predicting the risk of parasite or pathogen introduction and establishment (e.g. predicting pathways of West Nile virus and H5N1 avian influenza introduction).
- The WRA system is a question-based scoring method for intentional introductions (of plants). The Australian WRA has already been successfully adapted for other countries (see e.g. this workshop's presentations by Doria Gordon)

and for other taxa in at least some countries - including Freshwater Fish, Marine Fish, Marine Invertebrates, Freshwater Invertebrates and Amphibians (see e.g. box below and this workshop's presentation by Gordon Copp).

Case study: Examples of publicly available tools

CLIMATE habitat-matching software

The CLIMATE software package matches the climates of selected regions around the world to the climate of other selected regions. The potential range of a species is produced as images and text. Bureau of Rural Sciences 2006 BRS Shop: Climate habitat-matching software, Australian Government, Canberra. The software package can be downloaded from <http://affashop.gov.au/product.asp?prodid=13506>

Weed Risk Assessment

Using the WRA (Australia) involves answering up to 49 questions about the new species to be imported. The questions include information about the plant's; climatic preferences, biological attributes, reproductive and dispersal methods and invasiveness elsewhere.

The WRA uses the responses to the questions to generate a numerical score. The score is used to determine an outcome: accept, reject or further evaluate the species. The WRA also makes a prediction as to whether a species may be a weed of agriculture or the environment. The questionnaire form and scoring form and further information can be downloaded from <http://www.daff.gov.au/ba/reviews/weeds/system>

The Australian WRA has been successfully adapted for other countries and for other taxa.

Electronic toolkits: Identifying potentially invasive non-native species of marine and freshwater species: fish, invertebrates, amphibians (UK)

The Centre for Environment, Fisheries & Aquaculture Science (Cefas) (UK) has made available electronic tool kits for free download. <http://www.cefas.co.uk/projects/risks-and-impacts-of-non-native-species/decision-support-tools.aspx> to download the following: Freshwater Fish Invasiveness Scoring Kit (FISK); Marine Fish Invasiveness Scoring Kit (MFISK); Marine Invertebrate Invasiveness Scoring Kit (MI-ISK); Freshwater Invertebrate Invasiveness Scoring Kit (FI-ISK); Amphibian Invasiveness Scoring Kit (AmphISK)

Risk Analysis Tool for the prevention of alien plants establishment and invasion and a Vectors and Pathways Analysis Tool (In Spanish and English)

I3N is the invasive species thematic network of the Inter-American Biodiversity Information Network (IABIN). In January 2008 the development of the first two I3N value added tools was completed: a Risk Analysis Tool for the prevention of alien plant establishment and invasion, and a Vectors and Pathways Analysis Tool, both developed to work in association with the I3N database on invasive alien species. Translations to English are underway and will be made available in the future.

A manual to use these tools is available at http://i3n.iabin.net/documents/pdf/MANUAL_TOOLS_FOR_PREVENTION.pdf and a presentation about the tools is available in Spanish at <http://i3n.iabin.net/HerramientasdePrevenciondeInvasionesBiologicasdelI3N.html>

English versions are available from: http://i3n.iabin.net/tools/web_tools.html

(Also see Appendix)

4. Gaps in the international regulatory framework

The workshop endorsed and reiterated the concern expressed elsewhere in CBD discussions and documents that there is a significant gap in the international regulatory frameworks, relating to the lack of international standards for addressing animals that are invasive alien species but are not pests of plants under the International Plant Protection Convention (IPPC). In addition, the workshop expressed concern about alien species' pathogens and parasites that could pose risks to wildlife but that are not listed by the World Organization for Animal Health (OIE), and are therefore currently not adequately regulated. The workshop suggested that these gaps be addressed as soon as possible. See, e.g. UNEP/CBD/SBSTTA/11/INF/4, UNEP/CBD/COP/8/31, UNEP/CBD/SBSTTA/13/6, UNEP/CBD/COP/9/32.

Additional notes on gaps in the international regulatory framework

Zoonoses represent the majority of diseases in the last decade but there are gaps in global regulations for infectious disease, as follows:

World Trade Organization Sanitary and Phytosanitary Measures (WTO SPS) Agreement

- The WTO SPS Agreement does not address invasiveness of animals (nor do other international agreements). However, in the absence of global standards, one can fall back on the general provisions of WTO, in particular SPS Agreement Articles 5.1-5.3 and 5.7.
- Countries have extensive flexibility to adopt standards as they see fit to achieve their desired level of protection from animal invasions – so long as they comply with the broader WTO/SPS provisions.
- Countries can tighten animal import systems (or otherwise revise previous systems or decisions) as long as they follow the WTO/SPS provisions in doing so.

International Plant Protection Convention (IPPC)

- The International Plant Protection Convention (IPPC) is the principal agreement aimed at preventing the introduction and spread of pests of plants and plant products, with pest in this context defined as "... any species, strain or biotype of plant, animal or pathogenic agent, injurious to plants or plant products". International Standards for Phytosanitary Measures (ISPMs) are intended to harmonise phytosanitary measures, but decisions are made at country level.
- The scope of the IPPC is broad enough to be applied to certain animals in some situations – but only where the animal poses a direct or indirect threat to plants, and where it is not present or not widely distributed (and under official control), and could become established with unacceptable economic, environmental or societal impacts. This is why the lack of international standards to address animals that are not pests of plants under the IPPC constitutes such a major gap in the international regulatory framework (see section 4 above).
- More generally, the IPPC PRA models may provide useful guidance for pre-screening and other ISPMs for plant quarantine pests may likewise be useful in the establishment of international standards or procedures for dealing with animals.

World Organisation for Animal Health (OIE)

- OIE is intended for livestock and impacts on the environment is a minor consideration.
- OIE works with international "lists" of pathogen of concern – in other words, the decision about species of concern is taken at the international level. (Under IPPC, the decision about organisms of concern is taken at the country level, and hence there is more flexibility than under OIE)
- Quarantine is usually rigorous and effective for known pathogens, yet a major challenge is that many other unknown pathogens are present in animals that come into quarantine. Emerging infectious diseases are the most likely to cause problems.

Convention on International Trade in Endangered Species (CITES)

- The Convention on International Trade in Endangered Species (CITES) addresses conservation risks to the exporting countries of trade in certain listed animals. CITES does not address issues of risks to importing countries stemming from invasiveness or disease associated with traded species.
- Countries (or regions) have in some instances used their national legislation, which implements CITES to also regulate invasive alien species. Such an approach can have advantages as well as disadvantages (see case study).

Case study: Advantages and disadvantages of using CITES in the regulation of alien invasive species

Discussion during the workshop plenary included a debate on the wisdom of using existing legislation, which was "designed" to deal with issues other than invasiveness to also deal with the gap for live animal imports. For instance: European wildlife trade regulations, used to implement CITES, were also used to list animal species banned from import into the European Community due to invasiveness (including bullfrogs, red eared slider and ruddy duck). One advantage of the CITES system is that it has the power to investigate compliance, request data and issue trade bans, which other instruments often don't. A disadvantage is that using CITES implementing regulations to ban imports of potentially invasive species may be confusing and worry some CITES officials, who fear it will increase implementation costs. (See also –Simon Nemptzov presentation on CITES)

Some participants pointed out that any legislation that can be used to provide protection against invasiveness was better than none, while others pointed out that relying on existing legislation that had been designed for other purposes could result in an unsatisfactory piecemeal approach.

5. National implementation, strategic approaches, capacity

There was broad agreement that addressing invasive alien species at the national level is most effective when operating within an overall strategic framework in which practical implementation, overall vision, and legal and institutional arrangements are mutually supportive. This is equally true for pre-import risk assessment of live alien species and may require increased communication and/or cooperation among different national agencies - such as those implementing risk assessment under the mandates from IPPC, OIE, CBD, IMO, ICES, and others as applicable.

Capacity-building to implement the risk-assessment approach for the importation of live alien animal species is required at regional and national levels. Additional needs identified by the workshop include the following:

- datasets on which risk assessments can be based should be urgently developed.
- information-exchange mechanisms should be fostered and/or developed.
- risk-assessment templates and tools should be made more accessible and be widely distributed.
- completed risk assessments could be usefully shared
- efforts to revise / improve risk-assessment tools could be coordinated.
- funding is essential for further developing and testing of risk-assessment tools.

Additional notes on national implementation, strategic approaches, capacity

In terms of National Implementation:

- Implementation requires a country-by-country approach (rather than a standard model). Countries are different in level of development but also in level of trade, physical environment, language and administrative factors such as; legislative systems, international instruments they are members of (such as WTO, IPPC, OIE, CITES etc), and regulatory attitudes towards risk assessment (e.g. see case study on white list / black list).
- The need for support (e.g. many developing countries lack the data needed for the models discussed herein) and for regional cooperation are critical for enabling real implementation in developing countries.
- The development of legal frameworks is often more sensible at the end of a process that addresses capacity, motivation, incentives and budget rather than at the beginning.
- Maximizing the use of existing biosecurity systems to include environmental impacts has advantages – and also creates challenges such as the need for inter-agency cooperation at national level, which can be complicated.
- A country's existing provisions don't prevent it from adopting new and stricter standards. The WTO allows countries to change what they consider to be an "appropriate level of protection", but they need to justify the change with appropriate scientific evidence, etc.

In terms of Capacity and Resources:

- Capacity, motivation, and budget can be more limiting than lack of statutory authority in many countries.
- Some countries may not have resources to go beyond education and outreach, or may choose only to use voluntary Best Management Practices for industry at least for some time.
- Many of the models discussed require lots of data; acquiring it is a difficult and non-trivial task when resources are limited.
- Developing countries, especially Small Island developing States (SIDS), seeking information for risk assessment may find additional challenges where "similar ecosystems" or species under consideration are also in information- and resource poor countries.
- Information poor countries may have to rely on an exporting country for data and pre-export biosecurity and may be vulnerable to investment and diplomatic pressure

- Food security, livelihood issues and other considerations may mean that some types of animal imports are likely to grow significantly in many countries.

Case study: Aquaculture – likely future growth

Population growth over next decade will require large increase in aquatic food (40 million tonnes) and this will predominantly come from aquaculture (in many developing countries aquaculture will be the most realistic solution to meeting the growing food requirements of a rapidly increasing population) - Globally aquaculture and/or culture based fisheries have been responsible for more than 70% of aquatic introductions. In aquaculture, one of the challenges is that traits that make species "hardy" also make them more likely ecological invaders.

Case study: Different national approaches

White list vs. black list approach. Discussion focused on the use of a 'white list' approach (whereby species that are authorized for import are listed, and no import is allowed for species not on the list) to complement a "black list" approach (whereby species that are prohibited from import are listed).

Many participants were interested to know which countries used the white list approach. Participants from Australia, New Zealand and Israel explained how their countries apply the white lists approach. In addition, the workshop heard how the EU is preparing white list approach for aquaculture;

Species already in trade

Discussions on assessing risk for new proposed imports led to questions about what happens with species that are already in trade, predating any assessments done on them: can they be added to "black lists" or "white lists" after assessment?

Participants heard several national approaches to this:

Australia: for ornamental fish already in trade the government it is working through this issue in cooperation with stakeholders. Israel: an assessment can be done on a species already in trade, which can then be used to decide whether the species should go on the white list or black list, but it can be quite challenging to persuade people that something already in trade can no longer be imported. New Zealand:

for species already in the country, the Chief Technical Officer of relevant government agency can designate such species an "unwanted organism". This was done with ferrets for example. This designation does not make it illegal to possess the species, but it makes it illegal to breed or trade it, so the last survivors will eventually die out. In Mauritius this issue of species already in the country/trade has been discussed extensively during the development of the national invasives strategy and it has not yet been resolved. Japan: the raccoon (which had been imported previously) has been put on the blacklist. Owners can keep existing pets but no-one can buy raccoons as pets.

Provision of data for risk assessment

The Australian system relies in part on data provided by the potential importer who is applying whereas the Israeli system puts the onus on its administrators to assemble relevant information. The former has the advantage of limiting requests to serious applicants only, but the disadvantage of potential bias in the data. The latter has the advantage that data is collected consistently by the administration, but it puts a lot of resourcing requirements on the administration.

6. Sub-national and regional risk assessments

In addition to being carried out at national level, risk assessments can be conducted with respect to smaller or larger geographic and/or jurisdictional scales. For example, a country might choose to assess risks for different ecosystem types or biogeographic regions within the country. Alternatively, risks might be assessed at a regional (multi-country) scale, either by a regional entity such as the Secretariat of the Pacific Community (SPC), by a regional industry body, or by neighbouring countries cooperating to manage a transboundary ecosystem such as a watershed. Such regional cooperation can effectively increase in-country capacity. An example is the SPC's regional approach to risk assessment for aquaculture in the Pacific. Because environmental boundaries are more relevant to species than political boundaries, risk assessments at scales other than the national scale are often very appropriate.

Additional notes on sub-national and regional risk assessments

- Regional cooperation is urgently needed because developing countries do not have the capacity to implement complex processes.
- Regional cooperation can be used to share/harmonize standards, data/information, and scientific and analytical services.
- Small-scale assessment of risks is also important: For instance, a risk assessment at the European-scale would ignore the different likelihood of establishment in Europe's different climate zones; In addition, there is also a clear need for risk assessments to address the potential impact of invasive species on vulnerable ecosystems within national territories and on islands.

7. Awareness and stakeholder involvement

It was noted that public awareness, education and stakeholder engagement will increase the effectiveness and efficiency of pre-import risk assessment of live animals. Participants noted that in some cases voluntary measures by the private sector to assess risks from their imports may precede formal regulations, particularly where capacity is lacking. Furthermore, risk assessment as part of self regulation often continues in situations where a regulatory framework exists.

The workshop strongly suggested that public awareness and stakeholder involvement be incorporated into management programmes addressing intentional introductions of live animals (and their parasites or pathogens) in international trade.

Additional notes on awareness and stakeholder involvement

- Many of the factors influencing the demand in live animals (the types of species in the trade, volume of trade, and level of influence of export countries) can be expected to change over time, so investment in stakeholder consultation, cooperation and education is necessary.
- Pro-active cooperation between authorities and industry stakeholders can create win-win situations (see examples in box).

Case study: Stakeholder and authority cooperation in the pet industry and ornamental fish industry

Participants mentioned the following examples:

Industry bodies in the US such as the National Reptile Improvement Plan are building a toolkit for best management practices, aiming to reduce releases, escapes, and introduction of associated pathogens, among other risks. (While discussing this, it was also stated by others that there is not yet much data available to evaluate the efficacy of industry codes of conduct).

Israel: authorities have begun working with Israeli wildlife importers and major pet shop owners in order to find attractive species on the world market that pose a low risk for them to import in lieu of species on the Black List. This new cooperative initiative has been welcomed by the pet industry and greatly reduced feelings of frustration from having attractive but harmful species banned.

In Australia the authorities and the ornamental fish industry are working together on communication and management approaches for ornamental fish that are currently already in trade.

8. Information requirements and sharing

Additional notes on information requirements and sharing

- Risk assessment approaches should take into account the progression of a biological invasion from importation to release (or escape) into the environment, to establishment, to spread, and to impact - Hence many different kinds of information are required, including species traits, prior invasiveness, management options, etc. (also see case study and table 1)
- International exchange of such information would significantly contribute to capacity
- There are several tools for international capture and exchange of such information/data as well as for regional, national, and sub-national exchange (see e.g. workshop presentations by Michael Browne and Sergio Zalba, and see Appendix for global and regional examples). Most, if not all, are under resourced.
- Those carrying out Risk Assessment need to know the robustness of the information provided by these tools (e.g. on prior invasiveness). Data may be of variable quality.
- One of the key challenges for use of prior invasiveness data in risk assessment is that the term "invasive" is not used consistently but instead is used with widely diverging meanings/definitions. The invasive species data exchange standard under development by the Global Invasive Species Information Network (GISIN) is addressing this issue by 'atomizing' the constituent parts of the term 'invasive'.
- Another key challenge is resolving species names, which typically include common names, synonyms and typos.

Case study: Examples of types of information needed for risk assessment

International exchange of information would significantly contribute to national and regional capacity. Different kinds of information were mentioned by participants as needed for assessing risk of establishment, spread, negative impact, and difficulty of management (in case of invasiveness) of live animals that are intentionally introduced. Information about prior invasiveness elsewhere is key to many of these procedures, but so is information such as habitat preferences, tolerances and resilience, behaviour, reproduction strategy, and response options at different stages in its life cycle. There is a need for information about how and why animals have escaped or been released in the past, and known negative impacts (including economic data for cost benefit analysis).

Information requirements for spatial modelling include native and introduced range, point occurrence/observation data as well as climate layers at appropriate resolutions. Information about volume and frequency of live animal imports can be used to estimate propagule pressure, and best management practices and case studies are needed to incorporate mitigative measures in the assessment process (as appropriate). Identification tools, taxonomic support, bibliographies, and the contact details of experts all contribute to the knowledge base.

Some participants stated their experience that the most time consuming and difficult part of modelling is the generation and quality assessment of data. Thus global attempts to standardise and collate such data are important. Surprisingly, there are no known formal initiatives to share data that has been collected for modelling in order to reduce the magnitude of each separate modelling effort. (also see section on capacity).

Case study: reliability of sources of data/information

An issue that received a lot of discussion at the workshop was reliability of data sources and the credibility of major data providers. Many IAS databases use the literature and networks of experts as sources. They report explicit statements about invasiveness or they interpret invasiveness if it can be reasonably inferred, they document data sources and/or provide links to them so that users can follow easily, and they use controlled data entry, where an administrator or a group of administrators checks the data before it goes online. Many use expert reviewers to enhance credibility.

Participants suggested that databases (or other sources) could improve confidence by formalizing the protocols they use to accept or reject information, and that guidelines could be provided for dealing with data of 'doubtful' quality and/or origin. Another suggestion made was to rank data sources according to source type so that data quality can be assessed by users. Peer reviewed literature and research generated findings would be at one end of the scale, with technical reports and expert opinion, databases and checklists in the middle and 'grey literature' at the other end of the scale. It was pointed out that grey literature, while it needs to be used prudently, nevertheless has a role to play as a source of information given the overall shortage and geographic 'patchiness' of invasive species data and information.

Suggested risk-assessment approach

1. Overview

Extensive workshop discussions resulted in broad agreement on a suggested risk assessment approach (table 1) for the importation of live alien animal species (and their parasites or pathogens). This approach is not intended to be applied “off the shelf” as a risk assessment framework, but as generalised guidance. It is a “proof of concept” that can be developed further over time. Workshop participants hoped that this may assist countries or industries in developing or revising their own risk assessment procedures in the context of live alien animal imports. The set of questions in table 1 can be adapted and formalized so it is appropriate to country-specific legal authorities, industry-specific needs, data availability, technical capacities, and available resources. It should be noted that risk assessment is an evolving methodology that is being improved and revised continuously.

2. Key components

The suggested approach (see table 1), is organized around a list of questions that reflect the key components of a risk assessment. Also indicated are the kinds of data sources and tools needed to answer the questions, along with the capacity required to gather, develop, and apply the relevant data and tools. Table 1 (right) shows risk-assessment questions for imports of live alien animals, data needs, and capacity needs for the approaches listed. Annotations on these questions, information and data needs, and capacity needs are provided below, listed by question number.

Any country that formalizes these suggestions into a specific risk-assessment tool will need to take into account risk-assessment provisions of the following agreements, if the country is a party to them: the IPPC to the extent the species involved is a plant pest as defined thereunder; the OIE to the extent that the species or the pathogens or parasites involved are addressed by the OIE; and the World Trade Organization SPS Agreement, with particular attention to its provisions on risk assessment including, but not limited to, Article 5 provisions 5.1, 5.2, 5.3, and 5.7. Also indicated are the kinds of data sources and tools needed to answer the questions, along with the capacity required to gather, develop, and apply the relevant data and tools.

The order of questions in table 1 is logical in two respects: first, it reflects the progression of a biological invasion from importation to release (or escape) into the environment, to establishment, to spread, and to impact. Second, the order progresses from questions that require fewer data and less

technical capacity to answer to questions that require more data and/or greater technical capacity. Countries should not be daunted by the questions for which statistical or other models are desired, because the technical capacity that is required to develop models is a one-time investment; therefore the level of expertise required to apply those models afterwards is much lower.

If either data or capacity are limiting, then a country may reasonably choose to complete a risk assessment based on the answers to only one or a few questions. For example, in many cases, an assessment that progresses only through question 3 of table 1 may provide an assessment result, which a decision-maker can use with other relevant information to make a reasonable decision about whether to allow importation. If at a later stage additional data and/or capacities are available, then a more complete assessment could be performed, the results of which can be used to review and amend the initial decision as appropriate.

A country could therefore initiate reliable risk-assessment based decisions about importation while continuing to build additional risk-assessment capacities and strategic frameworks referred to in section 2.

3. Relation between the suggested risk-assessment approach and decision-making

Table 1 outlines an approach only to the risk-assessment stage; this stage ends with the provision of its results to the appropriate decision-maker(s).

In the decision-making phase, a relevant authority will decide whether to authorise the proposed alien species' import, the conditions of its import (if applicable), and any ongoing management required to reduce risks. Decision-makers, in addition to considering the results of the risk assessment, often may consider other factors such as: a pre-determined appropriate level of protection (or acceptable level of risk); costs and benefits associated with importing the species, food security and/or livelihoods; national policies; cost and effectiveness of various management options for reducing risk; and appropriate accountability to other countries. Such considerations form part of the decision-making process but should be independent of the assessment process itself.

Table 1.

Risk-assessment questions for imports of live alien animals, data needs, and capacity needs for the approaches listed.

Questions	Information and Data Needs	Capacity Needs
1. What is the taxon, identified to the most detailed level possible?	Standardized Global Species Checklist or globally unique identifier.	Taxonomic expertise; library resources or access to web-based taxonomic keys; identification tools
2. What are the circumstances of the proposed import?	Importer declaration of intent and any proposed or potential mitigation of invasiveness risk.	See Question 7
3. What is the history of invasiveness of this taxon anywhere? 3a..... of its pathogens or parasites? (Note: pathogens and parasites should be considered in subsequent questions but for purposes of brevity/simplicity this is not mentioned further in the table)	Information and data on invasiveness of taxon in other areas; occurrence of pathogens and parasites, and their invasiveness in other areas; data on whether the species has ever been imported anywhere before.	Experience interpreting scientific information on invasiveness; expertise in pathogens and parasites regarding possible shifts in hosts and vectors; data quality control; clear definition of invasiveness.
4. To what extent are the environmental conditions for persistence of this taxon present anywhere in the area of concern?	Maps of the occurrence of the taxon (or point data); at a minimum, maps of climatic match or other environmental attributes; ideally computerized data layers of climate and taxon occurrence.	At a minimum, the ability to compare maps of climatic or other environmental information across areas; ideally the ability to apply computer-based models of climate or other environmental matching.
5. What is the probability of establishment and spread of this taxon anywhere in the area of concern?	Biological information and data related to establishment and spread; ideally information on the traits used in available statistical models or models to be developed.	Statistical models (and the ability to apply them, as above) built on history of establishment and/or spread of similar taxa in similar ecosystems; expert judgment.
6. What is the potential impact of this taxon anywhere in the area of concern?	Biological information and data related to impact; ideally input data on traits of the taxon for available statistical models or models to be developed; additional assessment data may include asset/land use maps and/or data within the potential range.	Statistical models built on history of impact of similar taxa in similar ecosystems; expert judgment.
7. What mitigation options are available and appropriate? Iterate throughout the risk assessment process considering how mitigation could change the answers to questions 1-6.	Information on mitigation options and their feasibility and likely effectiveness based on past practices and the capacity within the country to apply them.	Experience with mitigation; infrastructure to assure feasibility and long-term maintenance of mitigation implementation; inspection, compliance and enforcement infrastructure (whether within a regulated or self-regulated framework), containment technology; surveillance and contingency planning.
8. Provide results of the risk assessment to decision-makers	Context of the proposed import together with answers to questions above and a concluding assessment of risk.	Expertise in risk communication.

Annotations to Table 1

Question 1.

Identification of the taxon should be to the lowest level feasible, including population and genetic structure where relevant. Identification of its potential pathogens/parasites may also be relevant.

Question 2.

By which pathways and vectors will the taxon be introduced? What is the intended use of the taxon, and what unintended uses might develop? The answers to these questions may help set priorities for risk assessment among taxa proposed for importation, particularly where resources are limited. For example, knowledge of intended use could help prioritize work across multiple risk assessments by separating those uses that might obviously be riskier (e.g., where direct release into the environment is intended, or where the likelihood of escape or release from confinement and/or propagule pressure could be high) than others (e.g., where a small number of animals is intended to be kept in strict confinement) These aspects would be more fully documented and explored under Question 7.

A risk assessment may be carried out with the aim to provide a basis for a decision on whether or not an alien species should be listed as an “invasive alien species,” “unwanted organism” or other specific determination for national regulatory purposes, without there being a proposal or application for import of the alien species. In such cases, question 2 may be of little relevance to the risk assessment.

Question 3.

Each country conducting a risk assessment needs to determine what it means by “invasive”. Existing databases on species invasiveness may be a valuable resource for answering this question, but definitions of “invasive” used by databases may not always be consistent with those of the country conducting the risk assessment. Available databases should therefore be interpreted carefully, with appropriate attention to data reliability and relevance. The most relevant data on invasiveness will be for other areas that are ecologically similar to the potential area of introduction. The lack of history of invasiveness does not imply that risk is low unless it is known that the taxon was introduced in large numbers and/or established and nevertheless failed to become invasive. That is, one possible explanation for lack of information on invasiveness is that the taxon has not previously been introduced in sufficient numbers or under conditions suitable for escape, establishment, and spread. It is also possible that relevant information has not been made public yet or that relevant databases have not been updated due to limited resources. Pathogens and parasites should be considered. In many cases the risk assessment for associated pathogens and parasites will depend not only on the alien animal species being considered, but on precisely where it would be coming from -- as this would change the mix of pathogens and parasites that would need to be considered. How this would be addressed in practice may depend on data availability, technical capacities, or other variables. If compelling evidence exists that the risk of invasiveness of the taxon is high, then question 3a may become moot. In that case a jurisdiction with limited capacity might choose to make a decision to restrict or prohibit import based on the answer to Question 3, without considering parasites and pathogens.

Question 4.

Where possible, biotic interactions, as well as maps of climate and other physical and chemical conditions (e.g., water quality for aquatic taxa), would be considered. Ideally, such information would exist in data layers in a computerized Geographic Information System (GIS). Parasites and pathogens should be considered, as explained under the annotation for Question 3.

Question 5.

Depending on the taxonomic group, traits included in a statistical model to predict establishment might include fecundity and other life-history characteristics, body size, behaviour and diet. An increasing number of statistical models to predict establishment and/or spread are available in some parts of the world for fishes, molluscs, reptiles and amphibians, birds and other taxa. See annotation for Question 2: intended and unintended uses may affect the probability of spread by anticipated and unanticipated transportation modes. If modelling potential spread is relevant to a risk assessment, an increasing array of diffusion and network modelling approaches are available. However, such models of spread require substantial technical capacity, data on the dispersal capacity of the taxon, and data on the movements of transportation modes (airline traffic, land-based transportation, and boat and ship traffic patterns) on which the taxon might “hitchhike”. Parasites and pathogens should be considered, as explained under the annotation for Question 3.

Question 6.

Each country conducting risk assessments needs to determine what it means by “impact,” which might include positive or negative consequences that are biological (including biodiversity, ecosystem and wildlife health) or economic (including human health, agriculture or livelihoods). An increasing number of statistical models to predict impact are available for some parts of the world, e.g., for fishes, molluscs, birds and other taxa. Parasites and pathogens should be considered, as explained under the annotation for Question 3.

Question 7.

Depending on the country’s policy, risk assessment might first be conducted without considering any mitigation (“unrestricted risk”), with mitigation being a relevant factor considered in making a final decision on importation. Alternatively, risk assessment may include consideration of how risk would be changed by implementation of mitigation options and alternative management practices. Results would be provided under step/question 8 to the relevant authority to make a decision about whether and under which management conditions importation would be allowed.

Management practices that might be considered as part of the assessment will depend on the taxon, capacity regarding resources and infrastructure, policy frameworks, and inspection and enforcement capacities (whether voluntary or regulatory). Such management practices might include permitting systems that can restrict use and/or mandate additional management steps; containment methods; surveillance and contingency plans; limitation of the number of individuals imported (controlling propagule pressure); importation of only one sex in sexually reproductive taxa; sterility of organisms or other genetic modification to reduce survival in nature; regulatory, educational programmes for consumers; and sanitary practices to reduce infestation by pathogens/parasites. Parasites and pathogens should be considered in their own right for mitigation as explained under the annotation for Question 3.

Question 8.

The results of the assessment should acknowledge uncertainty (and quantify it or categorize it where possible). The risk-assessment process ends when the assessment results are provided to the relevant decision-making authority that is empowered to make a decision whether or not importation is allowed – and, if so, appropriate restrictions or conditions (see section 3 above).

ANNEX 1. Presentations

Below is a list of Workshop presentations. Most of these can be found online at: <http://www.issg.org/Animal%20Imports%20Webpage/Presentations/Presentations.html>.

Best available technology in science and economics in pre-import animal risk analysis: Dr. David Lodge (University of Notre Dame, USA).

Overview of international law on pre-import risk screening of live animal imports in international trade: Peter Jenkins (Defenders of Wildlife, USA).

Pre-import animal screening of intentional animal introduction: what outcomes do we aim for and how do we obtain them:
Dr. Maj de Poorter, (IUCN ISSG, New Zealand).

Identifying suitable habitat, uncertainties, and pre-import decisions: Dr. Simon Barry (CSIRO- Mathematical and Information Sciences, Australia).

Forecasting spread and impact to inform pre-import decisions: Dr. Jon Bossenbroek (University of Toledo, USA).

Risk identification protocols for pre- and post-import screening of aquatic organisms (with emphasis on freshwater fishes): Dr. Gordon Copp (Centre for Environment, Fisheries and Aquaculture Science -CEFAS, UK).

Alien reptiles and amphibians: early progress toward predicting risk: Dr. Fred Kraus (Bishop Museum, Hawaii, USA).

Incorporating risk of pathogens, parasites and zoonotic disease in pre-import decisions: Dr. Peter Daszak (Centre for Conservation Medicine, USA).

Results of a plant screening test with implications for animal screening approaches: Dr. Doria Gordon (The Nature Conservancy and the University of Florida, USA).

Cost-benefit analysis of pre-import risk screening: Dr. Reuben Keller (University of Notre Dame, USA).

Socio-economic considerations for pre-import screening of live animals: Dr. Jamie K. Reaser (Pet Industry Joint Advisory Council-PIJAC).

The Convention on Biological Diversity and invasive alien species, from Rio to Bonn: Junko Shimura (CBD Secretariat).

Precautionary regulation of live animal imports -- a perspective on national capabilities in developing countries: Tomme Young (Consultant).

Role of IPPC in pre-import animal screening: Lesley Cree (Canadian Food Inspection Agency – on behalf of IPPC) CITES and Invasive Species: Simon Nemptzov (Israel Nature and Parks Authority, Israel).

Current national or regional practices for pre-import screening of animal species in international trade pre import screening of live animals for import into Australia: Nick Gascoigne (Exotic Species Regulation Section, Wildlife Branch, Department of the Environment, Water, Heritage and the Arts, Australia).

Israel's new regulatory approach to risk screening for live animal imports: Simon Nemptzov (Israel Nature and Parks Authority, Israel).

Regional Approach to and risk assessment for aquaculture species – South Pacific Ben Ponia, (Secretariat of the Pacific Community - SPC /Secrétariat général de la Communauté du Pacifique – CPS, New Caledonia).

Addressing intentional animal imports in the development of the Mauritius Invasive Alien Species Action Plan: John R Mauremootoo (Consultant).

Japanese IAS law and its practical implementation for addressing intentional animal imports: Tomoo Mizutani (Dept of IAS control and eradication, Nature Conservation Bureau, Ministry of the Environment, Japan).

The role of international information exchange tools in pre-import screening and invasion risk analysis: Michael Browne (Manager Global Invasive Species Database, ISSG, New Zealand).

Networking information on IAS in South America: first steps toward standardized risk analysis tools (Sergio Zalba, Gekko-Grupo de Estudios en Conservacion y Manejo, Depto. de Biología, Bioquímica y Farmacia, Argentina).

ANNEX 2. Workshop Participants

Name	Workshop	Country
Barry, Simon	Landscape Monitoring and Modeling, Commonwealth Scientific and Industrial Research Organisation, Mathematical and Information Sciences	Australia
Bossenbroek, Jon	Department of Environmental Sciences, University of Toledo	USA
Browne, Michael	International Union for Conservation of Nature, Invasive Species Specialist Group	New Zealand
Burgiel, Stas	Global Invasive Species Programme & The Nature Conservancy	USA
Copp, Gordon	Salmon and Freshwater Fisheries Team, Centre for Environment, Fisheries and Aquaculture Science	UK
Cree, Lesley	Plant Health Division, Canadian Food Inspection Agency – for the International Plant Protection Convention	Canada
Cudmore, Becky	Fisheries and Oceans Canada, Centre of Expertise for Aquatic Risk Assessment	Canada
Daszak, Peter	Consortium for Conservation Medicine & Member of the Executive of the Scientific Committee, DIVERSITAS	USA
De Poorter, Maj	International Union for Conservation of Nature, Invasive Species Specialist Group & Centre for Biodiversity and Biosecurity, University of Auckland	New Zealand
Gascoigne, Nick	Exotic Species Regulation Section, Wildlife Branch, Department of Environment, Water, Heritage and the Arts	Australia
Gordon, Doria	The Nature Conservancy	USA
Hoff, Mike	U.S. Fish and Wildlife Service	USA
Howard, Geoffrey	International Union for Conservation of Nature, Eastern African Office & Global Invasive Species Programme	Kenya
Jenkins, Peter	Defenders of Wildlife	USA
Keller, Reuben	Centre for Aquatic Conservation, University of Notre Dame	USA
Kolar, Cindy	U.S. Geological Survey, Biological Resources Discipline	USA
Kraus, Fred	Bishop Museum, Department of Natural Science	USA
Lodge, David	Centre for Aquatic Conservation, University of Notre Dame	USA
Mandrak, Nicholas	Fisheries and Oceans Canada, Centre of Expertise for Aquatic Risk Assessment	Canada
Mauremootoo, John	Consultant for Mauritius Invasive Species Strategy Development	UK
McNulty, Joanna	Centre for Aquatic Conservation, University of Notre Dame	USA
Mendoza, Roberto	Universidad Autonoma de Nuevo Leon	Mexico
Mizutani, Tomoo	Dept. of IAS Control, Nature Conservation Bureau, Ministry of the Environment	Japan
Nemtzov, Simon	Israel Nature and Parks Authority	Israel
Perry, Joanne	Biosecurity Section, Research, Development and Improvement Division, Department of Conservation	New Zealand
Ploeg, Alex	Ornamental Fish International	The Netherlands
Ponia, Ben	Aquaculture Advisory, Secretariat Pacific Community	New Caledonia
Reaser, Jamie	Pet Industry Joint Advisory Council	USA
Ruffler, Heidi	Defenders of Wildlife	USA
Shimura, Junko	Secretariat of the Convention on Biological Diversity	Canada
Simpson, Annie	National Biological Information Infrastructure	USA
Smith, Katherine	Brown University	USA
Williams, Lori	National Invasive Species Council, U.S. Department of the Interior	USA
Windle, Phyllis	Union of Concerned Scientists	USA
Young, Tomme	Consultant	Germany
Zalba, Sergio	Grupo de Estudios en Conservacion y Manejo, Depto. de Biología, Bioquímica y Farmacia	Argentina

Appendix 1.

Publicly available resources that may assist risk assessment practitioners.

Participants and others Expert Workshop on Preventing Biological Invasions: Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade (University of Notre Dame, Indiana, USA, 9-11 April 2008), and other interested people, identified a number of publicly available resources that may be of assistance to practitioners of risk assessment in the context of pre-import screening of live animals in international trade (also online at: <http://www.issg.org/Animal%20Imports%20Webpage/Resources/Resources.html>).

Resources include:

- Risk assessment models & tools, handbooks, training materials.
- Some examples of national approaches to risk assessment.
- Resources on invasive alien species management in general with good risk assessment related content.
- Key Global and Regional information exchange tools on invasive alien specie.

I. Risk assessment models and tools

I.1 Risk assessment model (import and keeping of exotic vertebrates in Australia)

This report examines the factors that can be used to distinguish between species that pose a high risk of becoming a new pest and those that pose a lower risk. This information is used to construct a scientifically based risk assessment model to evaluate the risks posed by the import and keeping of exotic species in Australia. This report provides information and guidance that will assist those responsible for assessing and managing the risks posed by the import and keeping of exotic vertebrates, including government policy makers, quarantine officials and wildlife managers.

Citation: Bomford, M. 2003. Risk assessment for the import and keeping of exotic vertebrates in Australia. Australian Government Bureau of Rural Sciences: Canberra.

The report can be viewed at http://www.feral.org.au/index.cfm?fuseaction=search.ReferenceDetails&ID=6379&fer_ref_type=Report

I.2 Risk identification and assessment of non-native freshwater fishes (Technical Report –UK)

Copp, G.H., Garthwaite, R. & Gozlan, R.E. 2005. Risk identification and assessment of nonnative freshwater fishes: concepts and perspectives on protocols for the UK. Cefas Science Technical Report. The report is available at

<http://www.cefas.co.uk/publications/techrep/tech129.pdf>.

I.3 Evaluating the suitability of alien species for aquaculture: Species in Aquaculture: considerations for responsible use

Aquaculture is being used throughout the world as a means of providing food for a rapidly growing human population. In the majority of cases alien species are used as these species have been successfully used in aquaculture elsewhere and therefore there is less chance of failure. Unfortunately some of these species are able to escape captivity and become major invasives A new publication from the IUCN entitled 'Alien Species in Aquaculture: considerations for responsible use' reviews the use of non-native species in aquaculture and is intended to be used in evaluating the suitability of alien species for aquaculture before they are introduced. The publication can be obtained electronically from <http://www.issg.org/Animal%20Imports%20Webpage/Resources/references/aquaculture.pdf>.

I.4 ICES Code of Practice on the Introductions and Transfers of Marine Organisms

A bbrief outline of the International Council for the Exploration of the Sea (ICES) Code of Practice, 2005. The ICES Code of Practice sets forth recommended procedures and practices to diminish the risks of detrimental effects from the intentional introduction and transfer of marine (including brackish water) organisms. The Code is aimed at a broad audience since it applies to both public (commercial and governmental) and private (including scientific) interests. In short, any persons engaged in activities that could lead to the intentional or accidental release of exotic species should be aware of the procedures covered by the Code of Practice. The Code of Practice is available at <http://www.ices.dk/reports/general/2004/ICES%20Code%20of%20Practice%202005.pdf>

I.5 Climate habitat-matching software

The CLIMATE software package matches the climates of selected regions around the world to the climate of other selected regions. The potential range of a species within the analysis site is produced as images and text. Bureau of Rural Sciences 2006 BRS Shop: Climate habitat-matching software, Australian Government, Canberra. The software package can be downloaded from <http://affashop.gov.au/product.asp?prodid=13506>.

I.6 Guidelines to be used – application to amend the live import list (Australia)

Any one, whether a member of the public, a public institution or a commercial enterprise, can apply to the Minister for the Environment, Water, Heritage and the Arts to amend the Australian live import list, which is available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/index.html> to include a new species. The purpose for applying to amend the live import list to include a new species may be either commercial or non-commercial.

There are three documents the applicant must submit to the Department for the application to proceed to a decision. These are an application form and draft Terms of Reference that are submitted together, and a report assessing the potential impacts of the proposed import on the Australian environment. Due to the biological differences between groups of organisms, different application forms and suggested Terms of Reference have been developed:

- Guidelines for the import of live birds and terrestrial mammals (Australia) available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/amend/birds/index.html>
- Guidelines for the import of live fish and other mobile aquatic animals (Australia) available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/amend/fish/index.html>
- Guidelines for the import of live reptiles and amphibians (Australia) available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/amend/reptiles/index.html>
- Guidelines for the import of live sessile aquatic invertebrates (Australia) available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/amend/aquatic-invertebrates/index.html>
- Guidelines for the import of live terrestrial invertebrates (Australia) available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/amend/terrestrial-invertebrates/index.html>

I.7 Standard methodology to assess the risks from non-native species considered possible problems to the environment (UK) - Modules and example risk assessments

In response to a key recommendation from the Defra Review of Non-Native Species Policy in 2003, this project has developed a scheme for assessing the risks posed by any non-native organism to species, habitats or ecosystems in all or part of the UK. The UK non-native risk assessment scheme is based on internationally recognised procedures developed by the European and Mediterranean Plant Protection Organisation (EPPO) following International Plant Protection Convention standards for pest risk analysis. Six modules (and examples) are available from <http://www.defra.gov.uk/wildlife-countryside/resprog/findings/non-native-risks/index.htm> provide methods for identifying (using Excel spreadsheets)

1) Invasive attributes (taxon-specific: Plants, Marine fish, Amphibia, Marine invertebrates)

- 2) Evaluating pathways of introduction,
- 3) Determining the vulnerability of receptors,
- 4) Quantifying economic impacts,
- 5) Summarising risks and uncertainties and
- 6) Selecting risk management options.

Example Assessments for: Topmouth gudgeon; Japanese knotweed; Indian house crow; *Metarhizium anisopliae*, an insect fungal pathogen.

I.8 Electronic toolkits: Identifying potentially invasive non-native species of marine and freshwater species: fish, invertebrates, amphibians (UK)

The Centre for Environment, Fisheries & Aquaculture Science (Cefas) (UK) has made available electronic tool kits for free download. They are Crown Copyright (2007-2008). As such, these are freeware and may be freely distributed provided this notice is retained. No warranty, expressed or implied, is made and users should satisfy themselves as to the applicability of the results in any given circumstance. Visit at <http://www.cefas.co.uk/projects/risks-and-impacts-of-non-native-species/decision-support-tools.aspx> to download:

- Freshwater Fish Invasiveness Scoring Kit (FISK)
- Marine Fish Invasiveness Scoring Kit (MFISK)
- Marine Invertebrate Invasiveness Scoring Kit (MI-ISK)
- Freshwater Invertebrate Invasiveness Scoring Kit (FI-ISK)
- Amphibian Invasiveness Scoring Kit (AmphISK)

I.9 The Weed Risk Assessment (Australia)

The WRA system is a question-based scoring method for intentional introductions (plants). The Australian WRA has been successfully adapted for other countries and for other taxa (see e.g. workshop presentations by Doria Gordon, and Gordon Copp at <http://www.issg.org/Animal%20Imports%20Webpage/Presentations/Reference/PDFs/Gordonpaper.pdf> <http://www.issg.org/Animal%20Imports%20Webpage/Presentations/Reference/PDFs/Coppaper.pdf>

Using the WRA involves answering up to 49 questions on the new species to be imported. The questions include information of the plants; climatic preferences, biological attributes, reproductive and dispersal method. The WRA uses the responses to the questions to generate a numerical score. The score is used to determine an outcome: accept, reject or further evaluate for the species. The WRA also makes a prediction as to whether a species may be a weed of agriculture or the environment. The questionnaire form and scoring form and further information can be downloaded from <http://www.daff.gov.au/ba/reviews/weeds/system>.

I.10 Risk Analysis Tool for the prevention of alien plants establishment and invasion and a Vectors and Pathways Analysis Tool (In Spanish)

I3N is the invasive species thematic network of the Inter-American Biodiversity Information Network (IABIN) whose website is <http://www.iabin.net> (See Sergio Zalba's workshop presentation at <http://www.issg.org/Animal%20Imports%20Webpage/Presentations/Reference/PDFs/Zalbapaper.pdf>). In January 2008 the development of the first two I3N value added tools was completed: a Risk Analysis Tool for the prevention of alien plants establishment and invasion, and a Vectors and Pathways Analysis Tool, both developed to work in association with the database on invasive alien species in the network. Translations to English are underway and will be made available in the future. A manual to use these tools is available at http://i3n.iabin.net/documents/pdf/MANUAL_TOOLS_FOR_PREVENTION.pdf and a presentation about the tools is available in Spanish at <http://i3n.iabin.net/HerramientasdePrevenciondeInvasionesBiologicasdelI3N.html>.

I.11 Herramientas de Análisis de Riesgo de Establecimiento de Invasión & Herramientas de Análisis de Rutas y Vectores - (Las herramientas de Prevención de Invasiones Biológicas de I3N (IABIN))

Estas herramientas están asociadas en un mismo libro de Excel. La herramienta de Análisis de Riesgo de Establecimiento e Invasión (<http://i3n.iabin.net/>

[HerramientasdePrevenciondeInvasionesBiologicasdelI3N.html](http://www.daff.gov.au/ba/reviews/weeds/system)) se basa en 28 criterios agrupados en tres categorías: riesgo de establecimiento e invasión, impacto potencial y dificultad de control o erradicación en caso que la especie consiguiera invadir. Los criterios aprovechan la información recopilada en la base de datos nacional de I3N y propician el uso de los datos contenidos en los sistemas de los otros países de la región. La suma de los puntajes correspondientes a cada especie resulta en una indicación del riesgo asociado a su introducción. La herramienta de Análisis de Riesgo de Establecimiento e Invasión fue diseñada para optimizar los esfuerzos de monitoreo de vectores de introducción y propagación de especies invasoras. Incluye una lista detallada de vectores y rutas de dispersión y de los grupos de especies más comúnmente asociados a cada uno de ellos y un sistema de evaluación del riesgo relativo de introducción o transporte. Se consideran vectores naturales y antrópicos (facilitados por el ser humano) y, dentro de estos los que corresponden al transporte marítimo y fluvial, terrestre y aéreo, aquellos relacionados con el comercio de organismos vivos, al correo y a otros medios. El sistema de análisis de vectores de introducción y dispersión se basa en el análisis combinado de las probabilidades de introducción, establecimiento y dispersión, así como del impacto potencial y de las posibilidades de control de la especie en caso que consiga invadir. También: Manual con información detallada acerca del uso de ambas herramientas y de los módulos (hojas) complementarios, y una Presentación sobre las Herramientas de Prevención de Invasiones de I3N.

II. Handbooks

II.1 Import Risk Analysis Handbook (Australia)

This Import Risk Analysis Handbook describes the process Australia follows in assessing proposals to import animals, plants and/or other goods. It provides information about the risk analysis process for import proposals, with particular emphasis on those analyses with regulated steps under the Quarantine Regulations 2000. Risk analysis plays an important part in Australia's biosecurity protection. It assists the Australian Government in considering the level of quarantine risk that may be associated with the importation or proposed importation of animals, plants or other goods into Australia. The Department of Agriculture, Fisheries and Forestry and Biosecurity Australia 2007, Import Risk Analysis Handbook (2007) published by the Australian Government in Canberra is available at http://www.daff.gov.au/__data/assets/pdf_file/0011/399341/IRA_handbook_2007_WEB.pdf.

II.2 Animal Import Risk Analysis Handbook (New Zealand)

Based on the guidelines for import risk analysis outlined in the International Animal Health Code of the Office International des Epizooties - the world organisation for animal health, Import Risk Analysis; Animals and Animal Products is the first publication of its kind. Although it has a New Zealand focus, the bulk of the text will prove useful to regulatory veterinarians in all trading countries. The handbook will also be helpful to consultants working on behalf of importers and exporters of animals, and animal products as well as to academics involved in teaching veterinary epidemiology and its applications. Citation: Murray N. 2002. Import Risk Analysis – Animals and Animal products. New Zealand Ministry of Agriculture and Forestry, Wellington, New Zealand, 183pp. The handbook is available at: <http://www.biosecurity.govt.nz/pests-diseases/animals/risk/import-risk-analysis-handbook.htm#content>.

III. Training relating to risk assessment

III.1 Training manuals and related materials on pest risk analysis (IPPC)

Under the IPPC, three international standards for phytosanitary measures (ISPMs) on pest risk analysis (PRA) for plant pests have been developed and adopted:

- ISPM No. 2 (2007): Framework for pest risk analysis
- ISPM No. 11 (2004): Pest risk analysis for regulated pests including analysis of environmental risks and living modified organisms
- ISPM No. 21 (2004): Pest risk analysis for regulated non-quarantine pests.

To help countries understand and implement these standards, an international steering committee of PRA experts was established to develop a training course and training materials designed to increase countries' capacity to conduct PRA. The training course is designed to take place over 5 days, and consists of 14 presentations that explain PRA concepts and practices and 14 group exercises to demonstrate these. Three manuals and all other related materials are now available at the IPPC website: [https://www.ippc.int/servlet/CDSServlet?st](https://www.ippc.int/servlet/CDSServlet?status=ND0xODYyMDgmNj1lbiYzMz0qJjM3PWtvcw~~)

III.2 Global Invasive Species Programme - Invasive Species Training Courses

An Introduction to the Management of Invasive Alien Species - Module 3: Prevention. This module covers prevention in general, including risk assessment and is available at <http://www.gisp.org/publications/courses/ManaginginvasivesModule3.pdf>.

IV. Some examples of national approaches

IV.1 AusBIOSEC - the Australian Biosecurity System for Primary Production and the Environment.

AusBIOSEC is the Australian Biosecurity System for Primary Production and the Environment of the Department of Agriculture, Fisheries and Forestry. The system is being enhanced through a whole-of-government project, which was established in October 2005. The aim is to bring together, under an overarching national framework, biosecurity activities being undertaken by the Australian Government, state and territory governments, industry, landholders and other key stakeholders in primary production and the environment. The scope of this work is along the entire biosecurity continuum and includes managing pests and diseases of the terrestrial, freshwater and marine environments. It takes in everything from prevention and preparedness and emergency response to ongoing management of established species. More information about AusBIOSEC is available at <http://www.daff.gov.au/ba>.

IV.2 Strategic Approach to the Management of Ornamental Fish in Australia.

This report contains seven recommendations for the future management and regulation of the ornamental fish trade in Australia. Department of Agriculture, Fisheries and Forestry 2006. A strategic Approach to the Management of Ornamental Fish in Australia Natural Resource Management Ministerial Council, Canberra is available at http://www.affashop.gov.au/PdfFiles/ornamental_fish_report.pdf.

IV.3 National strategy for the management of vertebrate pest animals in Australia

The Australian Pest Animal Strategy is a national strategy for the management of vertebrate pest animals in Australia. The focus of the Strategy is to address the undesirable impacts caused by exotic vertebrate animals (mammals, birds, reptiles, amphibians, and fish) that have become pests in Australia, and to prevent the establishment of new exotic vertebrate pests. Citation: Department of the Environment, Water, Heritage and the Arts 2007 Australian Pest Animal Strategy-A national strategy for the management of vertebrate pest animals in Australia, Australian Government and Natural Resource Management Ministerial Council, Canberra. The Australian Pest Animal Strategy is available at <http://www.environment.gov.au/biodiversity/invasive/publications/pest-animal-strategy.html>.

IV.4 Australian list of specimens suitable for live import (the live import list)

The import of live plants and animals into Australia is regulated under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). All species permitted for import into Australia are included on the Species not identified on this list cannot be legally imported into Australia. The Live Import List (Australia) is available at <http://www.environment.gov.au/biodiversity/trade-use/lists/import/index.html>.

IV.5 Review of the impacts of introduced ornamental fish species that have established wild populations in Australia

Many ornamental fish are brought into Australia each year for stocking into home aquaria or garden ponds and between 12 and 14% of Australians are thought to keep aquaria. It is inevitable that some of these ornamental fish end up in natural waterways and although many don't survive, some have established feral populations. Accordingly, there has been a rise in the number of exotic freshwater ornamental fish species establishing wild populations in Australia over the past 20-30 years. Of the 41 alien fish species currently known to have established populations in Australia, up to 30 are now thought to have arrived in the country via the ornamental fish trade. This is a relatively large number of new species and there is growing concern over the potential for one or more of these to create an expensive environmental problem. The report: Review of the impacts of introduced ornamental fish species that have established wild populations in Australia has identified a number of key issues for the future management of feral ornamental fish in Australia that need to be urgently addressed. It is available at <http://www.environment.gov.au/biodiversity/invasive/publications/ornamental-fish.html>.

V. Resources on invasive alien species management in general but with good risk assessment related content

V.1 Invasive Alien Species: A Toolkit for Best Prevention and Management Practices

Wittenberg R. & Cock M.J.W. 2001 (eds) *Invasive Alien Species: A Toolkit for Best Prevention and Management Practices*. Publisher GISP, A great starting place for all aspects of management of invasive alien species. English, French and Spanish versions are available at: <http://www.gisp.org/publications/toolkit/Toolkiteng.pdf> <http://www.gisp.org/publications/toolkit/toolkitfr.pdf> <http://www.gisp.org/publications/toolkit/toolkitsp.pdf>.

<http://www.gisp.org/publications/toolkit/Toolkiteng.pdf> <http://www.gisp.org/publications/toolkit/toolkitfr.pdf> <http://www.gisp.org/publications/toolkit/toolkitsp.pdf>.

V.2 A Toolkit for the Economic Analysis of Invasive Species

Emerton, L. and G. Howard, 2008, *A Toolkit for the Economic Analysis of Invasive Species*. 100 pp. Produced by the IUCN Global Invasive Species Programme and IUCN Global Economics & the Environment Programme. Published by the Global Invasive Species Programme. Nairobi, 2008. The first part of the toolkit (Module 1) provides an introduction to invasive species as biological entities. It describes how and why they are important, as well as defining key terms and concepts in the science of invasion biology. Subsequent modules deal with the steps in economic analysis of invasive species: to understand the economic reasons why alien species are introduced, and become invasive (Module 2); establish the scope and level of the impacts of invasives and their management (Module 3); understand and define the economic costs and benefits of invasives (Module 4); value the economic effects of invasives on ecosystems and human wellbeing (Module 5); and support and inform decision-making and identify economic and financial instruments which can be used to address invasives (Module 6). The toolkit also contains a glossary of key scientific and economic terms, as well as a list of key readings on the economics of invasives.

English and French version are available for download from: <http://www.gisp.org/publications/toolkit/index.asp>.

(Warning: large file: 22 Mb)

V.3 Toolkit for developing legal and institutional frameworks for invasive alien species

Shine, C., 2008, *A toolkit for developing legal and institutional frameworks for invasive alien species*. 111 pp. Global Invasive Species Programme, Nairobi. Modular approach. Module 1 gives decision-makers an overview of what invasive alien species are and why they matter for economic as well as environmental reasons. Module 2 looks at the overall design of legal and institutional framework, pointing to the need to mainstream invasive alien species across all concerned sectors and dealing with the process of conducting a legal review. The next two modules address concrete legal requirements for implementing prevention (Module 3) and responding to biological invasions (Module 4). Module 5 focuses on getting results, in terms of effective oversight, enforcement and compliance mechanisms. Module 6 brings together the different components of international and regional cooperation and provides specific guidance on the interface between national regulations and the international trade

regime. Available for download from:

<http://www.gisp.org/publications/toolkit/index.asp>.

(Warning: large file: 13 Mb)

V.4 Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species

Shine C., Williams N. & Gündling L. 2000. A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species. Environmental Policy and Law Paper No. 40 IUCN - Environmental Law Centre A Contribution to the Global Invasive Species Programme IUCN - The World Conservation Union (Adobe Acrobat pdf). English, French and Spanish versions are available at:

<http://www.gisp.org/publications/toolkit/EPLP-040-En.pdf>

<http://www.gisp.org/publications/toolkit/EPLP-040-FR.pdf>

<http://www.gisp.org/publications/toolkit/EPLP40SP.pdf>

V.5 National and Regional Legislation

Young T., R. (2006). National and Regional Legislation for Promotion and Support to the Prevention, Control, and Eradication of Invasive Species. Biodiversity series, Paper No 108. 98 pp. Published by The World Bank Environment Department (2006). The publication addresses different aspects of the invasive alien species issue, but has a lot of content relating to prevention. Part I provides a conceptual and scientific summary and introduction, and Part II provides a very brief overview of some of the key global developments in the field, while Part III examines in greater detail the legislative tools available for use in the control of species introduction, and invasive species. Part IV discusses some of the special concerns relating to the process of building one, or more legislative frameworks utilizing the legislative tools described in Part III, and, provides, in some cases, a brief identification

of how the selection and use of those tools might differ within the developing country context. The publication can be downloaded from

http://www.wds.worldbank.org/external/default/main?pagePK=64193027&piPK=64187937&theSitePK=523679&menuPK=64187510&searchMenuPK=64187295&theSitePK=523679&entityID=000012009_20060308141046&searchMenuPK=64187295&theSitePK=523679

V.6 Assessment and control of biological invasion risks

Assessment and control of biological invasion risks Koike, Fumito, ed.; Clout, Mick N., ed.; Kawamichi, Mieko, ed.; De Poorter, Maj, ed.; Iwatsuki, Kunio, ed.. IUCN; Biodiversity Network Japan; Yokohama National University, JP; 2008

Biological invasion, an issue of growing importance due to the significant increase in international transportation and trade, can disturb the balance of local ecosystems and even destroy them. This collection of papers presented at the International Conference on Assessment and Control of Biological Invasion Risks held in August 2004 at Yokohama National University discusses risk assessment, risk management and eradication.

It also includes contributions reporting on the current status of invasion and the properties of alien species in East Asia. You can order a copy at http://www.earthprint.com/how_to_order.php or download a pdf from <http://www.issg.org/Animal%20Imports%20Webpage/Resources/references/assessment&control.pdf> If you have trouble with any of these options, please contact issg@auckland.ac.nz

V.7 IUCN Guidelines on IAS

IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species, approved by the 51st Meeting of the IUCN Council, February 2000

<http://data.iucn.org/themes/ssc/publications/policy/invasivesEng.htm>

IUCN Guías para la Prevención de Pérdidas de Diversidad Biológica Ocasionadas por Especies Exóticas Invasoras, aprobadas durante la 51ra Sesión del Consejo, Febrero del 2000 <http://data.iucn.org/themes/ssc/publications/policy/invasivesSp.htm>

Lignes directrices de l’IUCN pour la prévention de la perte de diversité biologique causée par des espèces exotiques envahissantes approuvées par le Conseil à sa 51e réunion, en février 2000 <http://data.iucn.org/themes/ssc/publications/policy/invasivesFr.htm>

V.8 IUCN Guidelines for Re-introductions

This is a comprehensive set of policy guidelines that ensure that the re-introductions effectively achieve their intended conservation benefit, and do not cause unfavorable environmental side-effects. These guidelines were approved by the 41st Meeting of IUCN Council in May 1995. They were translated into different languages that include French, Japanese, Korean, Spanish, Russian, Chinese, Arabic and German as well as English and produced in a booklet form in 1998. The following languages are available online: English, French, Japanese, Korean, Spanish and German. (see <http://>

www.iucnsscrg.org/policy_guidelines.html)

VI. Key global and regional information exchange tools on invasive alien species

VI.1 The Global Invasive Species Database

The Global Invasive Species Database (GISD) was designed by practitioners to provide support for awareness raising, inventory and response, including capacity building and site-based activities. It delivers detailed peer reviewed biological, ecological and management information about more than 500 of the world's worst IAS, tracking where they occur, their status, how and when they were introduced and their impacts. It is available at www.issg.org/database and mirrored by our longstanding partners at the National Biological Information Infrastructure (NBII) of the US Geological Survey at www.invasivespecies.net/database; The GISD is also available in CD-ROM format for use 'in the field' or in parts of the world where access to the internet is slow, unreliable or limited.

VI.2 Global Invasive Species Information Network (GISIN).

The goals of this system are to allow users of the world-wide-web to access the large amount of data that is available on invasive species. GISIN will enable 1) a centralized registry of web sites and services with information on invasive species, 2) web sites where end-users can contribute data and make it available to other web sites, 3) web sites with summaries, maps, and models of invasive species distributions based on all available data, and 4) web portals that allow browsing across all available invasive species data. Visit <http://www.gisinet.org> for more information on GISIN. GISIN is based on the framework originally created by NISbase, a collaboration between the Smithsonian Institution and the US Geological Survey (Greg Ruiz, Brian Steves, Pam Fuller, and Shawn Dalton). See <http://www.nisbase.org/nisbase/index.jsp> for more details.

VI.3 The Invasive Species Compendium

In 2001, CABI's Compendia programme consortia identified a need for a Compendium on Invasive Species in recognition of the threat posed by invasive species to the global economy and environment, which coincided, with a similar recognition by the US National Invasive Species Management Plan. An 'alpha' test version (see <http://www.cabi.org/datapage.asp?IDocID=180> for more information) demonstrates the major components of the Invasive Species Compendium on an innovative web platform, providing linkage through to the latest CAB Abstracts data on invasive species. The database contains around 1,000 species and is growing by the day. It is intended to be a time-saving encyclopaedic, interactive database that draws together scientific information

on all aspects of invasive species. The project is on track to be delivered in 2010 and by then we will have a content rich resource with query based search facilities and many other features, including weekly updates of a subset of the CAB Abstracts database. ISSG are key providers of biodiversity related content to the ISC.

VI.4 European regional information exchange resource - DAISIE

DAISIE is a pivotal instrument in developing a Europe-wide strategy that encompasses both the geographical scale of the problem and unites the study of different taxa in marine, freshwater and terrestrial environments. With direct access to national knowledge bases throughout Europe, those addressing the invasive alien species challenge will easily obtain data on which species are invasive or potentially invasive in particular habitats, and use this information in their planning efforts. Data has been collated for vertebrates, invertebrates, marine and inland aquatic organisms as well as plants from up to 63 countries/regions (including islands) in the wider Europe. Explore DAISIE at <http://www.daisie.ceh.ac.uk>

VI.5 Invasive species thematic network of the Inter-American Biodiversity Information Network - I3N

The IABIN Invasives Information Network (I3N) integrates information from Western Hemisphere countries to support the detection and management of invasive alien species. I3N provides capacity building, electronic tools, and support for database development and increased access to information. Several I3N member countries (Argentina, Brazil, Colombia, Costa Rica, Jamaica, Paraguay, Uruguay) have developed Web sites displaying their invasive species information in standardized formats, and more are under development. Visit <http://i3n.iabin.net> for more information.

VI.6 Listservers: Aliens-L & PestNet

Aliens-L is a listserv dedicated to invasive species, run by IUCN. Its primary focus is on the environmental, biodiversity and/or livelihood impacts of invasive alien species. It allows users to freely seek and share information on alien invasive species and issues, and the threats posed by them. To subscribe, send a blank email to: aliens-l-join@indaba.iucn.org When you have subscribed you will receive a message with instructions for using the list.

Another list server with an Asia-Pacific regional range and more of an agricultural pest and weed emphasis is PestNet. It offers a preliminary species identification service using expert taxonomists to identify pest and weed species from users' images issues.

To subscribe, send a blank email to: PestNet-subscribe@

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 International Plant Protection Convention
<https://www.ippc.int/IPP/En/default.jsp>

Report of CBD COP 8 Decision VIII/27 Alien species that threaten ecosystems, habitats or species (Article 8 (h)): further consideration of gaps and inconsistencies in the international regulatory framework UNEP/CBD/COP/8/31, 2006.

In-depth review of ongoing work on alien species that threaten ecosystems, habitats or species.

Addendum Preliminary report of expert workshop on best practices for pre-import screening of live animals in International Trade (9-11 April 2008, South Bend, Indiana, USA) UNEP/CBD/COP/9/INF/32/Add.1

CBD COP 9 Decision IX/4 In-depth review of ongoing work on alien species that threaten ecosystems, habitats or Species.
<http://www.cbd.int/convention/decisions.shtml?m=COP-09&id=11647&lg=0>

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