Secretariat of the Convention on Biological Diversity

CBD Technical Series No. 48

48

# Pets, Aquarium, and Terrarium Species: Best Practices for Addressing Risks to Biodiversity

Convention on Biological Diversity

UNEP

GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

CBD Technical Series No. 48

# Pets, Aquarium, and Terrarium Species: Best Practices for Addressing Risks to Biodiversity

Published by the Secretariat of the Convention on Biological Diversity ISBN: 92-9225-204-6




This publication was produced with the financial assistance of the Government of Spain. The views reported in this publication do not necessarily represent those of the Government of Spain, nor of the Secretariat of the Convention on Biological Diversity.



Citation:
Secretariat of the Convention on Biological Diversity (2010). Pets, Aquarium, and Terrarium Species: Best Practices for Addressing Risks to Biodiversity. Montreal, SCBD, Technical Series No. 48, 45 pages.

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Cover photos courtesy of (top to bottom): Kohichi Goka, Flickr.com/mineobskuriteter, Kohichi Goka, and Ian McHenry

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# FOREWORD

Globalization combined with growing Internet use has facilitated the export and import of exotic pets, aquarium and terrarium species to an unprecedented rate. Pet sales in the United States alone were estimated at nearly US$ 50 billion in 2010, according to the American Pet Products Association. Interest in exotic pets is also evident in urban areas of Europe, Japan and other parts of the world. The Food and Agriculture Organization of the United Nations has reported that 1.5 billion live ornamental fish are exported every year, with exports coming from over 100 countries.

While the international trade of pet species represents opportunities for economic growth, it can also lead to the spread of invasive alien species and the overharvesting of rare endemic species. Released or escaped exotic pets or aquarium and terrarium species may survive in the wild and become invasive. Invasive alien species disturb the functioning of ecosystems and are one of the leading threats to biodiversity. According to the IUCN Red List of Threatened Species, updated in 2010, 30% of bird species are threatened due to over-exploitation and invasive alien species. Invasive alien species impact 67% of threatened birds on islands, where feral animals introduced as pets are suspected to be in part responsible.

Currently, there is no specific international standard in place to address risks of invasions associated with pets, aquarium and terrarium species as well as live bait and food. Those species may include fish, reptiles, insects and a wide range of other organisms, including pathogens. The Conference of the Parties to the Convention on Biological Diversity (CBD) has requested information on best practices to prevent these risks (decision IX/4).

This publication documents some of the problems resulting from invasive alien species introduced via the pet and aquarium trade, provides examples of risk assessment and regulatory practices employed by some Parties, and presents measures to prevent further invasions of species which pose a significant risk. This information is relevant to importers/exporters operating in large markets, pet owners, and decision-makers considering appropriate control measures for invasive alien species. Facts are presented in a format accessible to all readers, ranging from the local to global levels, to take appropriate actions with regard to invasive alien species introduced as pets, aquarium and terrarium species.

The third edition of the Global Biodiversity Outlook, published by Secretariat of the CBD in 2010, clearly shows that the introduction of invasive alien species is growing in parallel with greater demand for transport, trade, and tourism; and yet most countries lack adequate control measures for introduction pathways. In particular, control at national borders must be strengthened to address the risk of introducing invasive alien species as pets, aquarium and terrarium species. It is my deepest wish that this publication enlightens its readers to better mitigate the risk of invasive alien species introductions.

Ahmed Djoghlaf
Executive Secretary
Convention on Biological Diversity

## ACKNOWLEDGEMENTS

The Secretariat of the Convention on Biological Diversity wishes to acknowledge all those who contributed to this publication, including Dr Sarah Simons, Mr. Michael Browne, Ms. Adela Reid, Ms. Annie Webb, Ms. Annie Cung, Ms. Caroline Belair, Ms. Jacqueline Grekin, Dr Jo Mulongoy, members of the Workshop Steering Committee, including Mr. Stas Burgiel, Ms. Maj De Poorter, Mr. Peter T. Jenkins and Mr. David Lodge, and all those who participated in the Expert Workshop on Best Practices for Pre-Import Screening of Live Animals, held at the University of Notre Dame in Indiana, United States of America, from 9 to 11 April 2008. The Secretariat would also like to thank those who kindly allowed us to use their photographs in this publication. Finally, The Secretariat would like to thank the Government of Spain for making it possible to print this publication.

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **ABARE** | Australian Bureau of Agricultural and Resource Economics |
| **AHTEG** | Ad Hoc Technical Expert Group |
| **AIMS** | Agricultural Internet Monitoring System |
| **ANTSF** | Aquatic Nuisance Species Task Force (United States) |
| **APEC** | Asia-Pacific Economic Cooperation |
| **APPMA** | American Pet Product Manufacturers Association |
| **AusBIOSEC** | Australian Biosecurity System for Primary Production and the Environment |
| **AQIS** | Australian Quarantine and Inspection Service |
| **BD** | Batrachocytrium dendrobatidis |
| **CBD** | Convention on Biological Diversity |
| **CISIS** | Comprehensive Invasive Species Information System |
| **CITES** | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| **COP** | Conference of the Parties |
| **EPBC Act** | Environment Protection and Biodiversity Conservation Act 1999 (Australia) |
| **EPPO** | European Plant Protection Organisation |
| **DAISIE** | Delivering Alien Invasive Species Inventories for Europe |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **GAA** | Global Aquaculture Alliance |
| **GDP** | Gross Domestic Product |
| **GISD** | Global Invasive Species Database |
| **GISIN** | Global Invasive Species Information Network |
| **GISP** | Global Invasive Species Programme |
| **GRIS** | Global Register of Invasive Species |
| **HHT** | Marine Aquarium Council's Handling, Husbandry and Transport International Standard |
| **IABIN** | Inter-American Biodiversity Information Network |
| **IA CRC** | Invasive Animals Cooperative Research Centre (Australia) |
| **IBC** | Institutional Biosafety Committee of the Department of Fisheries (Thailand) |
| **ICES** | International Council for the Exploration of the Sea |
| **IMO** | International Maritime Organization |
| **INPA** | Israel Nature and Parks Authority |
| **IPPC** | International Plant Protection Convention |
| **ISPM** | International Standards for Phytosanitary Measures |
| **IUCN** | International Union for Conservation of Nature |
| **IUCN-ISSG** | International Union for Conservation of Nature Invasive Species Specialist Group |
| **IUCN/SSC** | International Union for Conservation of Nature Species Survival Commission |
| **NBII** | National Biological Information Infrastructure |
| **NIASS** | National Invasive Species Strategy for the Republic of Mauritius |
| **NLAC-MU** | National Laboratory Animal Centre, Mahidol University (Thailand) |
| **MAC** | Marine Aquarium Council |
| **OATA** | Ornamental Aquatic Trade Association |
| **OBIS** | Ocean Biogeographic Information System |
| **OFI** | Ornamental Fish International |
| **OIE** | World Organization for Animal Health |
| **PAW** | Partnership for Action against Wildlife Crime |
| **PIAA** | Pet Industry Association of Australia |
| **PIJAC** | Pet Industry Joint Advisory Council |
| **RISS** | Regional Invasive Species Strategy |
| **SARS** | Severe Acute Respiratory Syndrome |
| **SIDS** | Small Island Developing States |
| **SPC** | Secretariat of the Pacific Community |
| **SPS Agreement** | World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures |
| **UAS** | Uncategorized Alien Species |
| **UNCLOS** | United Nations Convention on the Law of the Sea |
| **USDA** | United States Department of Agriculture |
| **USFWS** | United States Fish and Wildlife Service |
| **WTO** | World Trade Organization |

## EXECUTIVE SUMMARY

Invasive alien species are a direct driver of biodiversity loss, and considered a cross-cutting issue of the CBD, a key matter of relevance to all major biomes. In addition, invasive alien species have been estimated to cost our economies hundreds of billions of dollars each year, due to both the economic implications of present invasions to agriculture and ecosystem services, as well as the high cost of eradication efforts. At the same time, the pet trade has the potential to generate significant socio-economic benefits, including benefits for developing states.

The movement of live animals and plants around the world, facilitated by increased global trade and the accessibility of online marketing tools, poses a risk of spreading invasive species and their associated problems around the globe more widely and more rapidly. The existing international regulatory framework does not cover the introduction of species such as pets, aquarium, and terrarium species, live bait and live food, which constitute a significant risk to ecosystems. Measures which would not impede the trade of species with the lowest risk of harm to native biodiversity are needed.

One third of the world's most damaging aquatic invasive species are a result of aquarium or ornamental releases. The information collected through the expert workshop on best practices for pre-import screening of live animals held in Indiana, United States of America, from 9 to 11 April 2008 demonstrate that effective prevention strategies can be targeted where needed though risk-assessment practices. This edition of the CBD Technical Series provides a resource to those Parties or Governments who wish to establish their own import/export control mechanisms to determine how they may effectively and efficiently evaluate the risks posed by the potential import/export of live animals and plants as pets, aquarium and terrariums species as well as mechanisms to control these imports or exports if the risk level warrants such control.

This publication also provides a list of information resources which may be utilized by those who wish to conduct a risk assessment on a particular species. As the best predictor of invasiveness is previous invasiveness elsewhere, these resources are essential tools in the effort to avoid the damage caused by invasive alien species, and to protect native biodiversity and local economies.

# 1. INTRODUCTION

Invasive alien species are considered to be one of the direct drivers of biodiversity loss globally, and threaten ecosystems, habitat, and species. Invasive alien species cause losses in agriculture, forestry, and fisheries. They carry and spread parasites and infectious diseases to wild animals, plants and even humans. One third of the aquatic invasive species identified as the worst in the world have been identified as aquarium or ornamental releases (Padilla and Williams, 2004). Moreover, damage by invasive species has been shown to result in devastating economic costs to agriculture and natural resources industries (Pimentel et al, 2005).

The live animal trade constantly moves thousands of animal species around the world, contributing to alien species invasions and posing risks of spreading animal and human diseases globally. In 2005, the Ad Hoc Technical Expert Group (AHTEG) on Gaps and Inconsistencies in the International Regulatory Framework in Relation to Invasive Alien Species noted "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)," (SCBD 2005b) and identified introduced pets, including aquarium species, such as fish, reptiles, and insects, and live bait and live food, that can become invasive, as a major group that is not adequately regulated.

In 2006, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) endorsed the above AHTEG's findings, and "*Urged* 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" (decision VIII/23, paragraph 53).

In 2008, the ninth meeting of the COP invited "Parties, other Governments and relevant organizations to submit to the Executive Secretary examples of 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".

This publication focuses on best practices for addressing the risks associated with the introduction of live animal species as pets, aquarium and terrarium species, including live bait and food animals (chapters 2 and 3) based on the submissions from Parties, short papers submitted to the expert workshop on best practices for pre-import screening of live animals held in Indiana, United States of America, from 9 to 11 April 2008, and the workshop's main findings (chapters 4 and 5). The pathway of introduction of alien species as pets and others demonstrated in this publication is a clear gap in the existing international regulatory framework. The relevant stakeholders may find practical ways to address invasive alien species with the information presented in this publication. Problems associated with invasive aquarium and terrarium plants and the farming of exotic species for human food are beyond the scope of this paper. Further information on these practices is necessary in the near future.

## 2. THE IMPORT OF ALIEN SPECIES AS PETS: IMPLICATIONS FOR BIODIVERSITY

Many people would not consider their families complete without a pet or an animal. Hobbyists often invest much time and money into animal keeping (Reaser and Meyers, 2008; Reaser 2008). The human-animal bond can be quite strong and some cultures also have a traditional association with specific species (Reaser 2008). There are many psychological and physical human health benefits related to pet ownership including stress reduction, reduced risk of cardiovascular disease, reduced rates of allergies and asthma in children who have had pets in the first year of life (see review in Reaser and Meyers 2008 for specific studies).

The American Pet Product Manufacturers Association (APPMA) estimates that there are 360 million pets in the United States and that almost 63 per cent of American households have at least one pet (APPMA 2007a). The percentage is similar for Australia, with 53 per cent of people owning a cat or dog (Hill 2006). In the United Kingdom, about 50 per cent of households have at least one pet (McNicolas et al. 2005). In the United States alone, the annual market value for pet purchase and care is approximately US$ 40.8 billion annually (APPMA 2007b).

However, pets such as cats, rats, reptiles, amphibians, fish and aquarium and terrarium plants are often not found in the natural environment. The pet trade, especially deliberate and accidental release of pets and aquarium species, is a serious problem in terms of invasive alien species pathways (Bomford et al. 2008). Pet abandonment has become one of the most challenging pathways to address (Reaser and Meyers 2008). Furthermore, once abandoned pets become established, eradication and control programmes are very costly and often face opposition by animal rights groups.

Some of the greatest risks for pets being released into the environment are most likely associated with:

- Consumers/pet owners;
- Non-regulated sales such as through the Internet, newspapers, hobbyist shows and others;
- Pets that are free or inexpensive;
- Species that reproduce quickly and easily in captivity, grow to a large size and have aggressive temperaments;
- Species that are native to a region that is similar in climate and geography to where they are kept as pets.

Classroom/laboratory activities are also a very high risk segment for the release of pets. Raising tadpoles, caterpillars and other animals is popular and educational, but the organisms are occasionally released into the natural environment. These animals also become problematic during school holidays and summer breaks.

**Once an alien species has been introduced to a new country there is no such thing as zero risk of escape or release.**

(Bomford et al. 2008)

Invasive, non-native animals, as well as pathogens for humans or wildlife carried in the live animal trade pose major risks to global biodiversity, the economy, and to human and animal health. Negative impacts on native species include predation, competition for food and other resources, hybridization and other genetic effects, spread of disease and parasites, and poisoning of native predators. In addition, many species develop new behaviours when introduced to new environments, with unpredictable impacts.

## 2.1. AQUARIUM AND ORNAMENTAL FISH

Worldwide, keeping ornamental fish in aquaria is a popular hobby in homes, public places and businesses. In the United Kingdom, the population of pet fish is approximately 140 million (2.5 times the human population) and in Australia, 12 million is a conservative estimate (Marine and Coastal Committee 2005). In the United Kingdom, about 7 per cent of hobbyists keep more than 100 fish, which amounts to about 40 per cent of the pet fish owned in the United Kingdom and there are indications that this trend is global (Marine and Coastal Committee 2005). There is also an increase in the trade of "live rock", which are communities of dozens of species encrusting rocks sold for aquariums (Padilla and Williams 2004).

**Over one third of species on IUCN's list of worst aquatic invaders are ornamental and aquarium species.**

(Lowe et al 2000)

The United States, Western Europe and Japan are the greatest importers of marine aquarium species (plants and fish) and the United States imports 80 per cent of the trade in corals (Padilla and Williams 2004). Aquarium species have a high probability of surviving and reproducing as they are often traded as adults and weaker individuals are weeded out during collection and transport (Wabnitz et al. 2003). Aquarium release is the largest source of introduced fish in Florida (United States) (Padilla and Williams 2004).

Aquarium fish represent a huge reservoir of invasive species with more than 5000 species traded globally (McDowall 2004). Released aquarium species displace and prey on native species, carry pathogens, clog waterways and interfere with ecosystem function (see specific references in review by Padilla and Williams 2004). In the United States, an estimated 65 per cent of established alien fish species are likely to have originated from the aquarium trade (Courtenay and Stauffer 1990). In Australia, 77 per cent of introduced alien fish originated from the ornamental fish trade (Koehn and MacKenzie 2004).

**The Ornamental Aquarium Fish Trade in Australia**

Ornamental fish are a significant threat to freshwater ecosystems in Australia. Imports were worth about US$ 3.87 million from 2002-2003 (ABARE 2004). Each jurisdiction in Australia has different regulations and management regimes for the ornamental fish trade. It is uncertain what species are being traded in Australia, and in what abundance.

- The ornamental aquarium fish trade in Australia is estimated to be worth about US$ 350 million annually (Marine and Coastal Committee 2005). This figure includes commercial fish breeding facilities, wholesale traders, retail outlets and the hobby industry.
- About 12-14 per cent of the Australian population is estimated to participate in the aquarist hobby (Patrick 1998).
- Approximately 60 per cent of aquarium fish are supplied domestically by breeders while about 40 per cent are imported (PIAA).
- Approximately 34 exotic freshwater species have established populations, 22 of which are thought to have been introduced via the ornamental fish industry (Lintermans 2004).

The Pet Industry Association of Australia (PIAA), in association with state and territory governments, has supported the review and the implementation of recommendations for a strategic approach to the management of ornamental fish in Australia (Marine and Coastal Committee 2005). These recommendations include the need for a nationally recognized noxious species list; new management frameworks for the ornamental fish sector as a whole; and improved consultation and communication with stakeholders through a comprehensive communication plan. Challenges include a lack of personnel trained to identify aquarium species; a strong unrecorded, unregulated informal trade practice among hobbyists; insufficiently updated lists of invasive plants and aquatic organisms; and lack of a guide to the variations in regulations across jurisdictions (Marine and Coastal Committee 2005).

***Caulerpa taxifolia***

*Caulerpa taxifolia* is a green macroalga identified by the IUCN SSC Invasive Species Specialists Group as one of the 100 worst invasive species in the world. The original introduction of *Caulerpa taxifolia* to the wild was made by the Monaco Oceanographic Museum into the Mediterranean Sea in 1984 as a result of tank-cleaning activities. From there it spread into the Mediterranean at a rate of about 50 kilometres per year (Walters, 2009) and now covers some 13,000 hectares of seabed (GISD). DNA analysis linked the invasive strain to a native population in Queensland, Australia. Clones had been nurtured in various aquaria for approximately 14 years prior to the Monaco introduction. Invasive populations of the aquarium strain (confirmed by DNA forensics) have since been found in the Adriatic Sea and in two lagoons off of the West Coast of the United States (Walters, 2009).

The *C. taxifolia* aquarium strain is highly problematic as it forms large meadows which overwhelm other algal species and seagrasses through increased competition for food and/or light resources, as well as reducing the available habitat for native fish species. It also produces toxic caulerpenyne compounds which cause problems for native species. Fish that are able to feed on *C. taxifolia* accumulate these toxins in their bodies and thus are no longer an appropriate food source. Additionally, the impact on fish habitat has also resulted in a decreased catch for local fishers.

Dispersion of *C. taxifolia* is suspected to occur through two main pathways: boating and the aquarium trade. Fragments of the algae may attach to boating equipment such as anchors and then be widely dispersed. *C. taxifolia* remains very popular with aquarium hobbyists and available for purchase both through online mechanisms as well as through local specialty shops (Walters 2009). Such pathways imply possibilities of rapid spread of *C. taxifolia* to multiple locations globally with relative ease.

Several eradication methods attempted for *C. taxifolia*, such as manual harvesting and suction pumps, have been unsuccessful. Complete eradication in California resulted from covering the algae with weighted-down black tarpaulins, and injecting chlorine under the tarps, at a cost of over US$7 million. "The most cost-effective management strategy is to prevent the introduction of *C. taxifolia* into coastal waters," (Walters 2009).

The *Caulpera taxifolia* forms large meadows which overwhelm other algal species and seagrasses and reduces the available habitat for native fish species. Photo: Alexander Meinesz.

## 2.2. TERRARIUM SPECIES, REPTILES AND AMPHIBIANS

Exotic reptiles and amphibians have been widely introduced into the environment by humans and their rate of growth is increasing exponentially (Kraus 2008; Kraus, in review). At least 5745 introductions of 675 taxa have been documented in the literature, of which 1060 populations of 322 species have become successfully established (Kraus 2008). Over 30 per cent of reported exotic reptile and amphibian introductions around the world have resulted in established populations (although this may be an overestimation since many introductions are unknown and un-established populations may not be reported) (Bomford et al 2005). There are 4 key factors which correlate most strongly with the establishment success of exotic reptiles and amphibians (there are many additional factors):

- Number of release events (the release of large numbers of animals at different times increases the chances of establishment);
- Climate match (introduced to a climate similar to their original range);
- History of establishing exotic populations elsewhere;
- Taxonomic group (some families are more successful than others).

Some nations may wish to strictly ban trade in foreign herpetofauna (reptiles) — an approach that has been successful for Australia and New Zealand (Kraus 2008). It is important that jurisdictions implement their screening systems through a responsible agency or leading authority.

**The Red-Eared Slider Turtle**

The red-eared slider turtle (*Trachemys scripta)* is a popular pet, with a remarkable ability to invade novel climates. Native to the United States of America, it has been grown there on turtle farms for the purpose of export in the pet, aquarium, and Asian live food trade. Escape and abandonment of pet turtles have resulted in the establishment of populations all over the world, including Australia, both East and South East Asia, Europe (Spain, France, England, and Cyprus), the Caribbean, Israel, Bahrain, Guam, and South Africa (GISD 2010c). Red-eared sliders may damage populations of native turtles and amphibians, as well as invertebrates which the slider targets for food. The basking behaviour of the slider may also impact nesting birds, as the slider may push nests into the water preventing the survival of the eggs. Red-eared sliders may also directly impact young birds through predation. They are also known to be carriers of *Salmonella* bacteria, and may transmit it to humans, resulting in Salmonellosis (infection with *Salmonella,* which causes similar symptoms to food poisoning).

Due to the successful invasive history of *Trachemys scripta*, and the potential for significant damage, it may no longer be legally imported into the European Union (GISD 2010c and GISP 2010).

The red-eared slider turtle is a popular pet, but its release into the wild contributes to the loss of invertebrates and young birds through predation and damage from their basking behaviour. Red-eared sliders are remarkably invasive and have established populations in Australia, Asia, Europe, the Middle East, Africa, and the Caribbean. Photo: Miguel Sicilia.

It has been suggested that another potentially successful measure, although seldom used, would be to require dealers to post bonds against the escape or release of animals, and instituting a per-animal tax which would support a variety of initiatives: to help internalize control costs of new incursions; to develop responsible programmes for humanely disposing of unwanted pets; and to work with the pet industry to reduce the volume of pet releases (Kraus 2008).

## 2.3. PREDATORS

Invasive predators can cause significant biodiversity loss and damage to native ecosystems. Their predation may result in unsustainable population losses of native prey species. Their presence may also adversely affect native predators, who will experience increased competition. Invasives may exhibit shorter generation times and more voracious appetites than native species, preventing the recovery of native prey. Further, the presence of invasive predator species may cause further damage to native populations which have been affected by multiple invasives.

**The Feral Cat**

Cats (*Felis catus*) are very popular pets, and as a result have been introduced all over the world. In the United States, the feral cat population has been estimated at over 30 million. They kill about 465 million wild birds a year (Pimental et al 2000).

Cats have demonstrated significant adaptability in their dietary habits, contributing to their successful invasions (Dickman 1996). Cats in mainland populations generally prey more heavily on mammals than island feral cats, which prey mostly on birds (see review Pitt and Witmer 2006). Cats are one of the most important biological factors causing the decline or extinction of mainland and island birds. Cats are also hosts and reservoirs for various zoonotic diseases.

While feral cats are extremely destructive to native species, especially on islands, the control of feral cats is controversial as some public advocacy groups are against culling the feral cat population. Eradication efforts are more successful on small unpopulated islands and where the number of non-target animals is low (Pitt and Witmer 2006).

Cats are one of the most important biological factors causing the decline or extinction of mainland and island birds. In the United States, the feral cat population kills about 465 million wild birds a year. Photo: Jorge Alvarez.

For instance, removal of an invasive predator may cause population increases for invasive prey species with consequences for native populations (Dickman 1996). Alternatively, the removal of the invasive prey may increase predation by invasive predators on already-stressed native prey populations (Collins et al, 2009). Furthermore, the presence of invasive predators may spoil efforts to reintroduce native prey species (Dickman 1996). The presence of invasive predators thus requires careful analysis prior to removal or re-integration programs.

Invasive predators tend to have higher invasion success when they have:

- High reproductive rates;
- Short generation times;
- A generalized diet; and
- Are small and/or secretive.

**The Nile Monitor Lizard**

Native to Africa, the Nile monitor lizard (*Varanus niloticus*) is imported for the pet industry into the United States, however, their size and aggressive temperament may make them inappropriate to have as pets (Pitt and Witmer, 2006). They were first detected in the wild in southern Florida in 1990, and it is thought that they have a successfully reproducing population.

The Nile monitor lizard is a voracious generalist predator, feeding on various freshwater, marine and terrestrial prey, including shellfish, invertebrates, fish, amphibians, reptiles, mammals, birds and bird eggs. They even forage in garbage dumps and can inhabit human settlements. They may also compete with the American alligator and American crocodile and threaten sea turtles and diamond back terrapins (due to egg predation), brown pelicans, burrowing owls and gopher tortoises. An eradication strategy involving extensive trapping has been proposed, but at the moment these efforts are limited (Pitt and Witmer, 2006).

The Nile monitor lizard is native to Africa and is imported into the Americas for the pet trade, but their size and aggressive temperament often leads to their release and abandonment. In Florida, they have established a wild population which is causing environmental damage and threatening other animal populations, such as sea turtles, through egg predation. Photo: Larry Woo.

**Invasive predators, especially rats and cats, are the leading cause of avian species extinctions on islands**

(Pitt and Witmer 2007).

## 2.4. PARASITES AND ZOONOSES

There is concern that trade in exotic pets may lead to the transmission of diseases from animals to people, and threaten livestock, international trade, rural livelihoods, native wildlife and the health of ecosystems (review by Karesh et al. 2005). The growing popularity of exotic pets has the potential to spread novel zoonoses to humans and new diseases to new regions of the world. It has been suggested that the greatest risk may be from pets that are taken directly from the wild (Reaser et al., 2008).

Zoonoses are diseases that are transmitted between animals and humans. Most emerging infectious diseases are zoonoses, which can be caused by international trade in wild animals and ownership of exotic pets (Chomel et al. 2007). For example:

**Emergence of *Batrachochytrium dendrobatidis*: Consequences of the amphibian trade**

The highly transmissible fungus *Batrachochytrium dendrobatidis* causes a disease called chytridiomycosis, and has resulted in global declines or extinctions of up to about 200 species of frogs (Skerratt et al., 2007) and the extinction of 30 per cent of amphibian species worldwide (Karesh et al., 2005). Amphibian chytridiomycosis has been described as the "worst infectious disease ever recorded among vertebrates in terms of the number of species impacted, and its propensity to drive them to extinction" (Gascon et al., 2007). The cause of the disease is suspected to be due to the global trade of amphibians, which often bring the animals in contact with wild populations (Fisher and Garner 2007).

In Japan, molecular technology to detect *Batrachochytrium dendrobatidis* rapidly from DNA was developed. Pets and wild frogs that are suspected to carry *Batrachochytrium dendrobatidis* are examined by collecting swab samples. Photo: Dr. K. Goka).

- The Severe Acute Respiratory Syndrome (SARS) outbreak of 2003 killed at least 774 people worldwide (WHO 2003) and had an estimated cost of US$ 20 billion to Asian countries in gross domestic product (GDP) terms for 2003, or US$ 60 billion of gross expenditure and business losses (Rossi and Walker 2005). The SARS coronavirus is associated with the trade in small carnivores, especially civets (see review by Karesh et al. 2005). In January 2004, the US Department of Health declared the country off-limits to civets as a precaution against the outbreak of SARS.
- In 2003, 40 people in the United States contracted Monkey Pox from imported pet wild African rats and infected prairie dogs from the US housed in the same facility (see review by Karesh et al. 2005).
- From 1994-1995, the US Department of Agriculture inspected 249 reptile shipments from 11 countries containing 117 690 animals. Just under half of them (54,376) in 97 shipments were infested with ticks that transmit diseases to humans and other animals including Lyme disease, heartwater disease and babesiosis (see review by Karesh et al. 2005).

Outbreaks of diseases resulting from the wildlife trade have caused billions of dollars in economic damage globally. Various species of exotic and wild animals flow through trading centres daily and they are often in contact with humans and other animal species before they are shipped, sold or even released back into the wild.

**By following proper quarantine, sanitation, and pest control practices; providing single species housing; and learning as much as possible about the needs and potential diseases of each species they work with, pet importers, distributors, and retailers can substantially reduce the risk of disease transmission.**

(Pet Industry Joint Advisory Council )

## 2.5. LIVE FOOD AND AQUACULTURE

The Food and Agriculture Organization (FAO) of the United Nations defines aquaculture as the "farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants (…)". Mariculture is the aquaculture or farming of marine species (GISP 2004 *). In the past 30 years, aquaculture has been promoted as a means of providing food and nutrition to populations in developing countries, obtaining economic resources from exports

* GISP has given SCBD permission to present information verbatim from their documents.

and reducing pressures on fisheries. Aquaculture is one of the fastest growing sectors of the global food economy, increasing by more than 10 per cent per year and accounting for over 30 per cent of all consumed finfish and shellfish (GISP 2004). The aquaculture sector now accounts for almost 50 per cent of the world's food fish production (Ponia 2008; www.APEC.org).

Tilapia (*Oreochromis spp*) is the common name for over 70 species of fish, of which at least eight are used for aquaculture. This process often requires cage culturing which reduces local water quality. Additionally, tilapias have been known to escape and establish wild populations, resulting in negative effects such as the decline of native fish populations. Photo: Miguel Sicilia.

Alien species dominate aquaculture production. In Latin America and the Caribbean, more than 65 per cent of aquaculture is from introduced species (Ponia 2008). By the year 2010, global production of Nile tilapia (*Oreochromis niloticus)* is forecast to approach 3 million tonnes per annum compared to just 200 thousand tonnes produced within its native range in 2004 (Ponia 2008). Another example is the Pacific white shrimp (*Litopenaeus vannamei),* which was introduced from Latin America after devastating losses from white-spot disease affected the Tiger shrimp (*Penaeus monodon)*. In the past few years, 80 per cent of the Tiger shrimp production, particularly in Asia, shifted to white shrimp. The current global production is estimated at 2 million tonnes per annum, making this an extremely large and widespread intentional introduction (Ponia 2008).

Aquaculture and mariculture provide pathways for unintentional introductions of alien species into shared waters, and aquaculture fisheries are responsible for over 70 per cent of all aquatic introductions (www.APEC.org). Introductions can occur through escaped fish as well as through their parasites and diseases. Impacts include species interactions such as predation, competition and hybridization, genetic effects and habitat alteration. The adverse impacts of such introductions stem also from unintended 'hitch-hikers' to aquaculture fish, which include both macro-organisms (e.g. snails, worms, larvae) and micro-organisms (parasites, bacteria and viruses) (Ponia et al 2003). Rural livelihoods, food security, poverty alleviation and public health may be at risk from these invasive species and significant economic losses in international trade may occur (Ponia et al 2003).

Escapees from aquaculture/mariculture farms also contribute to invasive populations. Most farmed marine organisms are fed on pellets manufactured from wild caught forage or bait fish such as anchovies and herring, which are

### Market Impacts of the Golden Apple Snail

The golden apple snail (*Pomacea canaliculata*) was introduced intentionally into Asia in 1980 to be cultured as a high-protein food source for local consumption as well as for export. It has since invaded Asian rice agro-ecosystems, spreading through extensive irrigation networks and feeding voraciously on rice seedlings.

According to a case-study in the Philippines, actual production losses amounted to between 70,000 – 100,000 tons of paddy, valued at $12.5 – 17.8 million in 1990. The total cost of the golden apple snail in 1990 to Philippines rice farmers was estimated between $28 and $45 million. This estimate included the loss of yields, in combination with costs pertaining to the control measures adopted (i.e., hand-picking, application of molluscicides) and costs for seedling replanting, but did not include non-market impacts such as health issues arising from pesticide usage and non-target impacts on biodiversity (Naylor 1996, from SCBD 2005).

A group of *P. Canaliculata* feeding on taro plants in an infested taro patch in Hawaii. Photo: Ken Hayes.

The bright pink eggs of the apple snail are easily visible in this denuded taro patch in Hawaii. Photo: Ken Hayes.

released directly into the pens (GISP 2004). Diseases may be introduced through frozen fish used for food pellets. A significant example is the appearance of a herpes virus in 1995 in Australia, which within two years decimated native pilchard stocks along the entire southern Australian coast. Analysis of causes provided good evidence of its source in frozen bait fish imported to South Australian tuna farms from Chile and/or California (Fletcher *et al* 1997; Hyatt *et al.* 1997; GISP 2004).

## 2.6. SOCIO-ECONOMIC CONSIDERATIONS ON THE LIVE ANIMAL TRADE

Socio-economic factors can have a large influence on live animal imports, and on the species that are more likely to become introduced and established. The characteristics of demand in a country importing live animals influence the risk of biological invasion (Reaser 2008). Factors which influence the demand in live animal imports in terms of species diversity and volume include:

- The economic status of the importing country (wealthier countries tend to import a larger variety of species, as well as more individual animals),
- Trends in popular culture (e.g., types of animals owned by publicly-recognizable people),
- Trends in the animal keeping hobby (e.g., desire for particular genetic characteristics such as colour morphs and breeds),
- The condition of the animals (e.g., disease and parasite free), and trade status of the exporting countries (e.g., ease of market access) (Reaser 2008).

The factors influencing the demand in live animals are dynamic and the types of species in the trade, volume of trade, and level of influence of export countries are expected to change over time (Reaser 2008).

The export of live animals via the pet industry also has the potential to generate significant economic benefits and wealth (Keller et al., 2008). The harvesting of wild animals, if done sustainably, can also provide an incentive for communitites to preserve the present biodiversity, and protect it from a variety of threats including invasive species, climate change, and others. For instance, Project Piaba, with the motto "Buy a fish, save a tree" promotes the sustainable harvest of ornamental fish destined for the pet trade (Chao, Petry, et al. 2001). The costs of potential invasions upon import must be carefully evaluated against these profits and benefits especially in developing countries.

**It is clear that invasive species are an expensive proposition, however, "The true challenge lies not in determining the precise costs of the impacts of exotic species, but in preventing further damage to natural and managed ecosystems."**

(Pimentel 2005)

**Economic Consequences of Invasive Alien Species**

Calculating the economic consequences of invasive species is a challenging endeavour. One must consider the economic benefits brought by such species, particularly those that contribute to domestic agriculture and food security as well as pets which contribute to our well-being and life satisfaction. However, one must also consider the various costs. These include the potential for significant disruption to industries that depend on the natural world, such as agriculture, forestry, and fisheries. Other industries less directly related to the environment may also be affected. Consider the example of invasive mussels in the Great Lakes region of North America, which cause significant damage to industry by settling on and eventually blocking water intake piping, filtration systems, and generating plants, causing significant damage, as well as covering and competing with native fauna for food and oxygen resources (Pimentel 2005). And of course, the severe environmental damage to native plants, animals, and ecosystems by invasive species must be considered, although these resources are invaluable.

In the United States alone, economic losses from invasive alien species were estimated to be approaching US$ 120 billion in 2005 (Pimentel 2005). This is a staggering number, and may be underestimated due to the difficulties in calculating the costs of environmental damage such as endangering native species.

# 3. INTERNATIONAL REGULATORY FRAMEWORK ON LIVE ANIMAL TRADE

## 3.1. INTERNATIONAL REGULATIONS

Regulating intentional imports of live animals can be challenging, as regulations must comply with international law (Jenkins 2008). The key international agreements that may apply to risks associated with live animal imports are: the Convention on Biological Diversity (CBD); International Plant Protection Convention (IPPC); World Organization for Animal Health (OIE); and World Trade Organization (WTO). A nation must be a Party to the agreement for the regulations to apply.

The main international regulations are as follows:

- **The Convention on Biological Diversity (CBD)**
  Article 8(h) of the CBD states that "Each contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". Invasive alien species have been addressed to varying degrees under the thematic work programmes. The guiding principles for the prevention, introduction, and mitigation of the impacts of alien species that threaten ecosystems, habitats or species (http://www.cbd.int/decision/cop/?id=7197)provide guidance to the Parties to develop strategies to avoid risks of introduction of alien species minimize the spread and impact of invasive alien species. There are 193 Parties to the Convention as of August 2010.
  www.cbd.int

- **International Plant Protection Convention (IPPC)**
  The International Plant Protection Convention is a treaty that aims to prevent introduction of pests of either plants or plant products in international trade. International Standards for Phytosanitary Measures (ISPMs) provide standards, guidelines and recommendations for phytosanitary measures applied by Members of the World Trade Organisation under the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). The IPPC has 172 Parties as of 2010.
  www.ippc.int

- **World Organisation for Animal Health (OIE)**
  The OIE is the intergovernmental organisation responsible for improving animal health worldwide and has 175 Parties as of 2010. International standards, guidelines and recommendations for animal health, outlined in the OIE Terrestrial Animal and Aquatic Codes and Manuals, aim to guarantee the safety of international trade in animals and animal products and to control animal diseases and zoonoses worldwide while avoiding unjustified sanitary barriers. Members of the World Trade Organisation must meet the relevant obligations of the above under the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement).
  www.oie.int

- **The WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)**
  Currently, there is no specific alien species content in the agreement, but it provides an international legal basis for all sanitary and phytosanitary measures that affect international trade. The focus is with pests, diseases and sanitary and phytosanitary issues. The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS agreement) may include prohibitions on proposed animal imports. However, such prohibitions must be "applied only to the extent necessary to protect human, animal or plant life or health" and be "based on scientific principles" (Art. 2.2). The goals of the SPS Agreement are not to stop arbitrary, unreasonable, and discriminatory restraints. There are 153 members to the WTO as of 2010.
  www.wto.org/

- **United Nations Convention on the Law of the Sea (UNCLOS)**
  Parties are requested to take measures "to prevent, reduce and control pollution of the marine environment resulting from … the intentional or accidental introduction of species alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto" (Article 196). There are 160 member states to UNCLOS as of 2010.
  www.unclos.com/

- **United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses**
  Parties are required to take measures to "prevent the introduction of species, alien or new, into an international watercourse which may have effects detrimental to the ecosystem of the watercourse resulting in significant harm to other watercourse States" (Article 22). This Convention is not yet entered into force.
  http://untreaty.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf

### 3.2. VOLUNTARY CODES

There are two voluntary codes and one technical guideline that establish principles and best practice guidance related to aquaculture. The voluntary codes are the **FAO Code of Conduct for Responsible Fisheries** (1995) and the International Council for the Exploration of the Sea: Code of Practice on the Introduction and Transfers of Marine Organisms (2004). The technical guideline is the FAO Technical Guidelines for Responsible Fisheries: Precautionary Approach to Capture Fisheries and Species Introductions (1995).

### 3.3. GAPS IN INTERNATIONAL LAW AND REGULATION

There is a significant gap in the international regulatory framework, relating to animals that are invasive alien species but are not pests of plants under the International Plant Protection Convention (IPPC) (CBD 2005). In addition, the World Organization for Animal Health (OIE) regulates only a small number of pathogens of alien species which could pose risks to wildlife. The OIE focuses on livestock, thus the pet trade would likely be neglected. Similarly, there are gaps in global regulations of infectious disease.

As no specific mandatory global standard exists on the import of live invasive alien species, nations have extensive flexibility to adopt standards as they see fit to achieve their desired level of protection (Jenkins 2008). However, they must always comply with the broader WTO SPS provisions, which regulate international trade. If a nation decides to prohibit the entry of a species that has not undergone an assessment, WTO members must carefully follow the SPS Agreement provisions. New Zealand and Australia have been successful in doing so in their implementation of pre-import regulatory systems that "screen out" potentially invasive species or pathogens. WTO members have the right to take "sanitary measures", which may include prohibitions on imports but they must be "applied only to the extent necessary to protect human, animal or plant life or health" and be "based on scientific principles" (Art. 2.2). These sanitary measures must, *inter alia*, include transparency, avoidance of discrimination against imports without justification and consistency of national protections across similar categories of risks. The SPS Agreement attempts to prevent arbitrary, unreasonable, and discriminatory restraints (Jenkins 2008).

However, nations can be WTO-compliant when temporarily prohibiting potentially invasive imports even in the absence of relevant scientific evidence, as long as they make reasonable attempts to obtain the needed information. The reasoning behind this is that if the species is not provisionally prohibited during risk assessment, the damages could be irreversible if that species turns out to be invasive (Jenkins 2008).

### 3.4. INTERNET TRADE AS A PATHWAY FOR INVASIVE ALIEN SPECIES

Internet subscribers are growing at an unprecedented rate, and Internet is fast becoming a globally accessible and convenient means of trade, opening up new pathways of invasive alien species introductions (GISP 2009). The variety of organisms traded over the Internet include aquatic species, insects, molluscs, mammals, plants, seeds, cut flowers, fruit and vegetables and microorganisms/pathogens carried on these organisms.

Internet subscribers have the capacity to order products from all over the globe that can be shipped to them in a matter of days or hours. Rare and exotic animals, many known to be potentially invasive, are often purchased and traded illegally over the Internet, and at an alarming rate, without normal controls and regulation. This is complicated by the fact that suppliers often misidentify the species provided, making control even more difficult.

An international regime is needed to control Internet trading using partnerships between quarantine services of individual countries and the postal service responsible for the delivery of goods ordered via the Internet. The United States Department of Agriculture (USDA) has an Internet Surveillance Project, which includes an Agricultural Internet Monitoring System (AIMS), however, this is only effective for the sites in the United States (GISP 2009). The Partnership for Action against Wildlife Crime (PAW) is developing a code of practice for web-site owners offering fauna and flora for sale in the United Kingdom (www.defra.gov.uk/paw/partner/default.htm).

**The Burmese Python**

The Burmese Python (*Python molurus bivittatus*) is a large snake (over 7 metres long) native to southern and southeast Asia. It is now established and expanding in Florida due to escapees from captive breeding farms or abandoned pets. Burmese pythons prey on and threaten native wildlife including the American alligator (*Alligator mississippiensis*) and the Key Largo woodrat (*Neotoma floridana smalli*) (Beck *et al*. undated). They compete with native snakes and have the potential to transmit disease to native reptiles (Schumacher 2006; Pitt and Wagner 2006). Burmese pythons and other reptiles are available on Internet market place and online pet shops..

Over 144,000 Burmese pythons have been imported into the United States for the exotic pet trade from 2000-2005. Since 1995, over 600 Burmese pythons were removed from Everglades National Park. Burmese pythons have high reproductive rates and their numbers have been increasing in the past few years (Beck et al. undated; Ferriter et al. 2006; see review by Pitt and Witmer 2007).

The Burmese Python is now established and expanding in Florida due to escaped or released pets. Burmese pythons prey on and threaten native wildlife including the American alligator (*Alligator mississippiensis*) and the Key Largo woodrat (*Neotoma floridana smalli*). Photo: Karunakar Rayker.

Removal of Burmese pythons is performed by the Florida Park Service, Fish and Wildlife, and Fire Rescue employees using radio tracking, pheromone lures, traps, hand capture and locator dogs (Pitt and Witmer 2007). State agencies are currently establishing regulations on the purchase and trade of invasive reptiles (Beck *et al.* undated; see review by Pitt and Witmer 2007). The National Park Service staff and specialized herpetologists are undertaking a special management plan to control pythons in the Everglades National Park, including detailed tracking. A "Python Hotline" has also been established to report sightings and request removal.

# 4. POLICY OPTIONS AND BEST PRACTICES: RISK ASSESSMENT

Once established, invasive alien species can cause significant damage to ecosystems, native biodiversity, and local economies. Eradicating entrenched invasive species is often a complex and expensive task. A front-line strategy to address this problem is preventing invasive species from gaining footholds in new ecosystems in the first place. In an attempt to achieve this aim, some countries have implemented processes to assess the risk of imports becoming invasive in the importing country, and have restricted imports that constitute a significant risk.

Risk assessment of live imports can increase the net economic value of international trade in live animals. In the case of Australia's ornamental plant trade, modeling has showed that screening tools are sufficiently accurate to produce economic benefits, and screening generated enough savings to pay for itself in a relatively short time. Savings originate in several ways, including reduced industrial losses to damage caused to agricultural species by invasives, prevention of disease in both agriculture and in the human population, and the avoidance of expensive and complex eradication strategies for established invasive populations. This evidence contradicts concerns that risk assessment accuracy may be insufficient to produce positive net economic benefits because only a small proportion of all introduced species escape, spread, become invasive and cause harm (Keller et al. 2008).

A major expert workshop aimed at elaborating best practices in pre-import risk screening for species of live animals carried in international trade was held in April 2008 at the University of Notre Dame in Indiana, United States of America (http://www.gisp.org/publications/policy/workshop-riskscreening-pettrade.pdf). The complex intertwining of science, economics, culture, social norms, practical implementation, and international laws and institutions were considered and discussed. A range of tools, processes/procedures and regulations that have been developed and adopted by different countries were also discussed, including their applicability to pre-import risk screening for species of live animals in international trade.

Workshop presentations illustrated that substantial recent progress has occurred on the development of concepts and technical tools for risk assessment of live animal species proposed for importation. Presenters demonstrated that it is now often possible to distinguish, with acceptable levels of accuracy, between alien species that will probably be harmful to the importing country and alien 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.

Recent developments in assessing the risks posed by potential import species enable more accurate and cost-effective management of those risks. For example, for species assessed as "likely to be benign," importation could be allowed with few, if any, conditions. Species 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. Such 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 (note that for simplicity, below, we refer mostly to "countries"). By applying risk assessment and decision-making in this way, the net economic value of international trade in live animals can likely be increased.

The workshop also addressed the gaps in the international regulatory framework, relating to the lack of international standards to address invasive alien species originating in the pet industry and the associated live animal trade. It was generally agreed that national implementation is not well developed for pre-import risk screening for animal species, especially outside the agricultural context, although there are some notable exceptions. The following information is largely based on the report arising from that discussion.

## 4.1. RISK ASSESSMENT AND SCREENING APPROACHES

To limit introductions of alien species and potential damage, some countries implement species screening and risk assessment (Keller et al. 2008). The risk assessment process evaluates the likelihood that a live import will become invasive, and the potential risks to native flora and fauna. The risk assessment, as well as other information such as potential economic benefits to both the importing and exporting countries, can then be used in order to determine if the import of the species will be permitted, forbidden, or subject to conditions.

Decision-making and risk assessment must balance legitimate social and economic objectives with appropriate safeguards for the environment, communities and public health (Shine et al. 2005; De Poorter 2008). Risk assessment should also be based on real risks and not perceived ones. "Cultural attitudes" toward certain types of animals may influence the risk assessment outcomes (Reaser 2008). For example, an invasive mammal, such as a feral cat, may be more accepted by the public in terms of risk than an invasive snake, even if there is significantly more scientific evidence of harm by the mammal (Reaser 2008).

Those conducting pre-screening should consider the costs and benefits of the alternatives to entry of a specific species. For example, evaluators can consider the risks, economic costs and benefits and environmental impacts associated with alternative species in the market place, and the possibility of substituting a native species or of using captive bred instead of wild caught species (Reaser et al., 2008; Reaser 2008).

The pre-screening consultation process should also include dialogue with law enforcement agencies in order to minimize the possibility that import restrictions of certain species will create a black-market enterprise. In some cases, it may be preferable to allow a conditional entry of a controlled number of individuals (e.g., permits, microchipping, and sterilization) rather than to prohibit a species entirely (Reaser 2008).

There was broad agreement among workshop participants that the best risk assessment procedures:

- are science-based;
- are transparent;
- are comparable and repeatable;
- are based on reliable data;
- use the best information available; and
- explicitly consider uncertainties.

Extensive workshop discussions resulted in broad agreement on a suggested risk assessment approach (see annex) 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 generalized guidance. Workshop participants hoped that this would 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 the annex can be adapted and formalized so it is appropriate to country-specific legal authorities, industry-specific needs, data availability, technical capacities and available resources. The approach as shown in the annex is a "proof of concept" that can be developed further over time. It should be noted that risk assessment is an evolving methodology that is being improved and revised continuously.

The approach outlined in the annex is based on the common set of risk assessment questions and approaches now successfully used by many countries; in addition, it is consistent with international risk assessment frameworks developed for other purposes such as the International Plant Protection Convention (IPPC), the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), the World Organization for Animal Health (OIE), and the International Council for the Exploration of the Sea (ICES).

The order of questions in the annex 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. Secondly, 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. However, 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; 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 the annex 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 or not. If at a later stage, additional data or capacities are available, there is the option of carrying out a more complete assessment, 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.

Risk assessment of live imports can reduce invasiveness risks and increase the net economic value of international trade in live animals. In the case of Australia's ornamental plant trade, modeling has showed that screening tools are sufficiently accurate to produce economic benefits, and screening generated enough savings to pay for itself in a relatively short time.

The Cartagena Protocol on Biosafety sets out provisions for Parties to conduct risk assessments of living modified organisms (LMOs). The "Guidance on Risk Assessment of Living Modified Organisms" contains a "Roadmap for Risk Assessment" and a flowchart for the entire process. This guidance is available in the final report of the AHTEG at http://www.cbd.int/doc/meetings/bs/bsrarm-02/official/bsrarm-02-05-en.doc. This guidance could also be used to assess the risks associated with the introduction of alien species.

### 4.2. DECISION-MAKING

In the decision-making phase, a relevant authority will decide whether or not to authorize 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, may often 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.

It is strongly suggested that a science-based risk assessment should be carried out, appropriate to the specific context, before a decision is made on whether or not to authorize the proposed import of live alien animal species into a country. The assessment should include biodiversity and environmental risks associated with the alien species as well as with their parasites and pathogens.

The workshop participants noted that the actual decision on whether or not to allow a proposed import of an alien species (and under what conditions, if any) is not a part of the risk assessment, but is made by a relevant authority

after the assessment has been conducted. 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.

Participants noted that for species assessed as "likely to be benign," importation could usually be allowed with few, if any, conditions. Species 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.

***Decision-making considerations:***

- Decision-making systems usually provide the option of allowing import either with no or few conditions or with stringent conditions as well as the option of not allowing import.
- 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.
- One of the challenges is to make a decision about the species that are assessed as "medium" risk (as opposed to species that are assessed as high or low risk, in which case decision-making is often more straightforward.). They could be invaders in lag phase, which could be cause for rejection, or they could be minor risk species and will stay that way.
- 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.

**Species Already in Trade**

Assessing risk for newly proposed imports lead to questions about what happens with species that are already in trade, before any assessments were done on them: can they be added to "black lists"(not permitted to be imported) or "white lists"(may be imported) after assessment?

Some nations have approached this in different ways:

**ISRAEL:** An assessment can be done on species already in trade which can then be used to decide whether the species should go on the white list or black list. It can be quite challenging to persuade people that something already in trade can no longer be imported.

**NEW ZEALAND:** The Chief Technical Officer of the relevant government agency can designate such species as an "unwanted organism". This was for example done with ferrets. It is not illegal to possess this species, however the "unwanted organism" designation makes it illegal to breed or trade the species. Eventually, the last surviving ones will die out.

**JAPAN:** The raccoon (which had been imported previously) has been put on the black list. Existing pets can stay with their owners, but no new raccoons can be purchased as pets.

## 4.3. SUB-NATIONAL AND REGIONAL RISK ASSESSMENTS

In addition to being carried out at a national level, risk assessments can be conducted with respect to smaller or larger geographic and/or jurisdictional scales. Regional cooperation is urgently needed, particularly where individual countries do not have the capacity to implement complex processes independently. Because environmental boundaries are more relevant to species than political boundaries, risk assessments at scales other than the national scale are often very appropriate.

Risks might be assessed at a regional (multi-country) scale by a regional entity such as the Secretariat of the Pacific Community (SPC), 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. Regional cooperation can be used to share/harmonize standards, share data, information, scientific and analytical services, etc.

## 4.4. NATIONAL APPROACHES TO RISK ASSESSMENT

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 assessments, as mandated under the IPPC, OIE, CBD, IMO, ICES and others, as applicable.

At the national level, there is no "one best practice" to prevent the introduction of invasives (Browne and De Poorter 2008). Risk assessments should distinguish between situations with different associated risks, such as diverse locations of origin, different pathways, and varied proposed end uses for the species. Several effective approaches exist, appropriate to different countries, with widely diverging capacities, diverse values and different priorities. Individual countries will use different institutional, legislative and practical approaches as they build on existing institutions to further develop strategic invasive alien species management (Browne and De Poorter 2008).

A country-by-country approach (rather than a standard model) can be more useful for implementation, since countries differ in terms of level of development, trade, environmental, physical and administrative factors, languages, legislative systems, membership in international instruments (such as WTO, IPPC, OIE, CITES) and regulatory attitudes.

***Different regulatory approaches:***

- **Black Lists and White Lists**
  White Lists indicate species which may be imported, while Black Lists indicate species which are not permitted to be imported. These two regulatory approaches each have their own advantages. Nemtzov found the White List approach to be preferable as it forbids import until a risk assessment can be conducted and it is assured the import is not a high-risk species. The Black List approach creates a permissive default which may generate a regulatory gap and contribute to further problems (Nemtzov 2008). White Lists and Black lists may also be used in combination. Australia, New Zealand and Israel utilize the White List approach. In addition, the Egyptian Environment Affairs Agency and European Union are preparing a White List approach for aquaculture.

- **Data Sourcing for Risk Assessments**
  There are two alternatives for the source of risk assessment data. Data can be provided by potential importers seeking import permission, or alternatively may be sought out by risk assessment personnel. Data provided by importers has the disadvantage of potential bias, but the advantage of limiting requests to serious applicants only. Data provision by government representatives implies significant resource requirements on behalf of the administration, but ensures that all data is collected consistently and objectively. The Australian system relies in part on data provided by applicants whereas the Israeli system relies on its administrators to assemble relevant information.

## 4.5. AWARENESS AND STAKEHOLDER INVOLVEMENT

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.

Public awareness, education and stakeholder engagement will increase the effectiveness and efficiency of pre-import risk assessment of live animals. 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. 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.

### 4.6. INDUSTRY-BASED MEASURES

The pet industry, which includes importers, distributors and retailers, has economic and ethical incentives to reduce the risk of invasive species from live species imports. They are inclined to invest in measures such as voluntary animal inspections, transport measures, post-import inspections, acclimation, quarantines, and publishing voluntary codes of conduct. At various stages along the pet trade pathway, animals can be inspected and, if necessary, treated for parasites, disease and other plants or animals that may have "hitchhiked" along with them.

The industry can also verify that pets and their associated pathogens and hitchhikers are not released from industry facilities or during transport. Codes of conduct exist that describe actions which can be taken by the industry or pet owners to minimize the risk of pets escaping or being released or abandoned.

Outreach campaigns are often conducted to raise awareness of the economic, environmental, and health implications of the release or abandonment of pets. The pet industry also may supply pet owners with information on how to take care of their pets, how to choose the right pet for their particular situation, and how to keep the pet healthy and adequately housed. This reduces the chances of the pet acquiring diseases and/or being abandoned or released into the wild. Consumers should also be informed on safe and humane alternatives to abandonment if they do decide to give up their pet. Outreach is also conducted to inform industry on minimizing the risk of invasive alien species problems and promoting responsible behaviours.

There have been several initiatives undertaken by the pet industry to minimize species invasions:

- **The Global Aquaculture Alliance**
  GAA is an international, non-profit trade association that aims to promote progress in environmentally and socially responsible aquaculture, and promotes best management practices for sustainable aquaculture through the Responsible Aquaculture Program (RAP), conferences and other activities. GAA is a voluntary programme that is primarily educational in nature. The RAP began as the "Guiding Principles for Responsible Aquaculture" which encourages environmental, economic, and social sustainability. These principles were expanded with the "Codes of Practice for Responsible Shrimp Farming". GAA then established the Best Aquaculture Practices standards for responsible shrimp farming, addressing social and environmental issues and food safety.

- **The Marine Aquarium Council**
  The Marine Aquarium Council (MAC) is an international organization bringing together conservation organizations, the aquarium industry, public aquariums, hobbyist groups and government agencies. MAC's goal is to ensure a responsible and sustainable marine aquarium trade, by conserving coral reefs and marine ecosystems through responsible collecting, handling, and transportation practices, and creating standards and certification for the collection and care of ornamental species. MAC also establishes independent certification of best practice standards and raises public awareness of the conservation role of the marine aquarium industry and hobbyists.

The MAC certification system provides environmental and quality international standards for fishers, exporters, importers, breeders, retailers and industry operators. MAC's Handling, Husbandry and Transport (HHT) International Standard ensures segregation from uncertified organisms, optimal health and proper documentation during export, import and retail. Organisms sold as MAC Certified must be handled only by MAC Certified professionals, facilities, exporters and retailers.

- **The Ornamental Aquatic Trade Association (OATA)**
  The Ornamental Aquatic Trade Association (OATA) is a non-profit organization representing the interests of ornamental fish importers, breeders, wholesalers, retailers and manufacturers of glass aquaria. OATA promotes and protects the interests of the ornamental aquatic trade industry in the United Kingdom on a wide range of issues at local, national, and international levels (OATA 2010).

  OATA has a code of conduct which contains provisions for safe and regulated fish imports and isolation and treatment of fish and aquarium water. This information is issued to ensure that Environmental Health Officers undertake effective inspections when issuing Pet Shop licenses. OATA has also produced outreach material related to invasive alien species such as the poster "Pet fish belong" which reminds consumers not to release pet/ornamental fish. OATA also prints "Ornamental fish and plants bought for aquariums and ponds must never be released into the wild" on plastic bags used in pet stores to package fish sold to consumers (2 million annually).

- **Ornamental Fish International (OFI)**
  Ornamental Fish International (OFI) was founded in 1980 and is the international trade association representing all sectors of the ornamental aquatic industry with 190 members in some 44 different countries worldwide. All OFI members have made a commitment to comply with to the OFI Code of Ethics, which commits them to "giving the welfare of livestock top priority at all times" and "to operate … according to honourable standards of trading" (OFI 2010).

- **The Pet Industry Joint Advisory Council (PIJAC)**
  The Pet Industry Advisory Council (PIJAC) is the world's largest pet trade association. It focuses on education, information, governmental and regulatory issues. It centres on issues relevant to the United States but also deals with international affairs. PIJAC recognizes that importation, captive breeding, acquisition, sale and/or possession of non-native species poses a threat to the environment.

  *Habitattitude* is a campaign run by PIJAC and partners to prevent introduction of unwanted pets into the natural environment. There are three elements to the campaign: 1) educate the consumers to make informed choices; 2) provide resources to provide better standards in animal care and maintenance; 3) Encourage pet owners to consider the alternatives available if they have problems with their pets. *Habitattitude* has targeted pet stores, product advertisements, industry trade shows and industry magazines in its campaign throughout the United States and Canada, but is planning on extending the programme into other sectors and countries. More information: www.pijac.org/habitattitude and www.habitattitude.ca

  *BD free 'phibs* is a campaign initiated by PIJAC to reduce the risk of transmission of *Batrachocytrium dendrobatidis* to amphibians through the pet trade. The campaign raises awareness of consumers and industry and provides best practices for inspection, quarantine, and treatment.

  PIJAC established the *Nonnative Pet Amnesty Day* in collaboration with the state of Florida. On certain dates, individuals may surrender their unwanted pets without fear of repercussions. The animals are often re-homed with pre-evaluated individuals. The *Amnesty Day* also includes educational and outreach activities on invasive alien species (http://www.myfwc.com/WILDLIFEHABITATS/Nonnative_AmnestyDayEvents.htm).

- **PetSmart**
  PetSmart, Inc. operates more than 1075 pet stores in the United States and Canada, supplying pets, pet food and pet supplies and offers complete pet training and pet adoption services. With every pet purchased, PetSmart provides guides which promote the *Habitattitude* message (see above).

  PetSmart has a zoonoses protocol for store employees to reduce the risk of transfer of zoonoses among animals or to humans. PetSmart also requires pet owners to fill out a customer sales record, and the information is retained by the corporation.

  PetSmart has also developed a *Vet Assured Program* providing guidance on standards for disease prevention, record keeping, transportation and zoonoses control. PetSmart vendors are required to meet these standards. PetSmart also pre-selects stores as "male" or "female" stores only for gerbils, rats, mice and guinea pigs and pets shipped and sold from these stores must be of the same gender, to reduce the likelihood of pets breeding, thus leading to release or abandonment. PetSmart also only purchases and sells ferrets and rabbits that are spayed and neutered.

- **Quality Marine**
  Quality Marine has been in the importing and distributing business for over 25 years and provides the aquarium industry with high quality marine fish and invertebrates. They send hundreds of shipments every month to the United States, Canada, Mexico, Europe, Asia, and worldwide. Quality Marine has policy manuals for state of the art acclimation, quarantine and water sterilization procedures. They also support responsible operators who collect in a sustainable manner and endeavor to protect the reef habitat. Their facilities are equipped with independent fill and drain systems allowing thousands of individual fish to have their own sterilized water supply. This minimizes the potential for the spread of parasites and other water-borne pathogens.

### 4.7. CAPACITY AND RESOURCING

Ideally, pre-import screening capacity is developed using a solid foundation of:

- Stakeholder support,
- Education/outreach,
- A well-enforced legal mandate/framework,
- Standardized risk assessment protocol,
- Credible scientific and economic information,
- Institutional and staff capacity, and
- Adequate financial resources (Reaser 2008).

No country will be able to fully pre-screen all live species in trade and there are large differences in the ability of governments to conduct or even establish pre-screening programmes.

Therefore, it is recommended that governments increase pre-screening capacity by investing in:

- Education/outreach initiatives that encourage voluntary screening by relevant industries,
- Consulting with stakeholders in order to build a foundation of support for pre-screening regulations/programmes,
- Databases that contain relevant biological and socio-economic data,
- Adoption of best management practices, and
- Risk management. (Reaser 2008)

Due to lack of capacity, decisions are often made using risk assessments that are based on limited data and information. Participants in the Indiana Workshop (see p. 21) thus recognized the need for capacity-building for risk assessment as a top priority.

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).

Other observations from the workshop regarding capacity needs include:

- Capacity, motivation, and budget can be more limiting than lack of statutory authority in many countries
- Some countries may never have resources to go beyond education and outreach, or may choose to not go beyond voluntary Best Management Practices for industry, at least for some time;
- Many of the models discussed require lots of data (acquiring data is a difficult and non-trivial task when resources are limited);
- Poorer nations may have to rely on the exporting country for data and pre-export biosecurity and they are 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.

### 4.8. INFORMATION EXCHANGE TOOLS AND INFORMATION-SHARING

Pre-import risk screening for invasive alien species relies heavily on easy access to good information about invasive alien species, including their prior invasiveness and the species, ecosystems and livelihoods that they impact. Risk analysis depends on the ability to predict which alien species could become problematic if they were introduced, and which would remain harmless. It is therefore of critical importance that knowledge about the prior invasiveness of a species anywhere in the world be widely available. This knowledge can be used to conduct a full risk assessment to determine if a species is likely to be invasive in a particular biogeographical context. "[Only] one factor has consistently high correlation with invasiveness: whether or not the species is invasive elsewhere" (Wittenberg and Cock 2001).

Information about prior invasiveness is key to effective prevention, but so is information such as habitat preferences, tolerances, resilience, behavior, reproductive strategy, and response options at different stages in a life cycle. There is a need for information about how and why animals escaped or were released in the past, and known negative impacts, particularly economic costs. Information about the volume and frequency of live animal imports can be used to estimate propagule pressure. Best management practices and case studies are needed to incorporate mitigation measures in the assessment process (as appropriate). Identification tools, taxonomic support, bibliographies, and the contact details of experts all contribute to the knowledge base (Browne and De Poorter 2008).

Finally, spatial modeling provides a tool which can help predict invasiveness and can be used to prioritize efforts to prevent or eradicate threatening species. Such techniques require information about both native and introduced ranges, point occurrence/observation data, and climate (Browne and De Poorter 2008).

Some participants from the Indiana Workshop stated that the most time-consuming and difficult part of modeling in risk assessment is quality assurance of the data. Therefore, global attempts to standardise and collate such data are important. These efforts would benefit from initiatives to share present data, so as to reduce the magnitude of each separate modeling effort (Browne and De Poorter 2008).

**Technical Tools for Risk Assessment**

The IUCN SSC Invasive Species Specialist Group (ISSG) wishes to draw attention to the following tools and initiatives that facilitate the capture and exchange of invasive species data and information.

**The IUCN Red List of Threatened Species**
Best practices also need to consider the potential impact of invasive species on endangered species. These efforts would be facilitated by improved links between the Global Invasive Species Database (GISD) and the IUCN Red List of Threatened Species, a comprehensive list which identifies "those species most in need of conservation attention if global extinction rates are to be reduced" (IUCN).

**The Global Invasive Species Database (GISD)**
At the global scale, efforts continue to improve the quality, geographic scope and accessibility of information about invasive alien species. The Global Invasive Species Database (GISD) has comprehensive peer-reviewed profiles on more than 520 of the world's worst invasive species. More than 2,500 experts have contributed information to the GISD to date and the flow of information is increasing. The GISD contains "the most detailed and accurate data on invasive alien species at the global scale..." (Kümpel and Baillie, 2007). Thanks to IUCN France's "l'initiative espèces envahissantes d'outre-mer" the GISD now has multilingual capacity. The GISD is integrated into the Regional Invasive Species Strategy (RISS) for the Pacific as a repository for information from the region (inventory and case studies). The GISD currently receives 1,100 unique visitors per day (75,000 hits per day).

**The Global Register of Invasive Species (GRIS)**
The Global Register of Invasive Species (GRIS) was promoted as a low-cost coarse pre-screening tool at the 'Expert Workshop on Live Animal Imports' held at the University of Notre Dame, Indiana, in April 2008. It is a reference list of the names of known invasive alien species. Global-scale data on marine invasives are currently being added to GRIS under a contract with the Ocean Biogeographic Information System (OBIS). ISSG will continue to seek funding to web-enable the prototype GRIS, to link it via web services to nomenclatural databases for validation of species names and to other data consumers and providers such as GBIF, OBIS and the Global Invasive Species Information Network (GISIN), and to increase its geographical and taxonomic coverage by uploading a number of large datasets.

**The Global Invasive Species Information Network (GISIN)**
ISSG continues to contribute to the development of the Global Invasive Species Information Network (GISIN), which provides a framework for the exchange of invasive species data and information between online databases. During meetings in June and August of 2008, parameters were agreed for three data models for sharing Occurrence Data, Species Status Data, and Species Resource URLs (for information types such as species profiles, images, video, experts, and references). Seven major databases are now providing data through the GISIN data exchange protocol. Presentations that will propose the three new data models as invasive species extensions to the Darwin Core have been given at the annual Biodiversity Standards-TDWG meetings in Fremantle, Australia, in October 2008.

**The Comprehensive Invasive Species Information System (CISIS)**
In partnership with the Global Invasive Species Programme (GISP), IABIN-I3N and BioNET International, GISIN, GISD and GRIS are developing a proposal which will leverage the strengths of existing global-scale invasive species information exchange initiatives and provide solutions for the collection and dissemination of invasive alien species data and information that suits all capacities. The CSIS proposal will help identify and prioritize gaps in existing data, as well as facilitate the transfer of information from one locale to another, aiding in the risk assessment process and the indentification of threats from novel imports or introductions (Browne and De Poorter 2008).

*The following entries are reproduced verbatim from Browne and De Poorter, with permission:*

**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. It is intended to be a time-saving encyclopaedic, interactive database that draws together scientific information on all aspects of invasive species. It is designed to help a wide variety of users to save time, by providing instant access to vital information, prepare lecture notes, reports, presentations and public information resources, compile maps, graphs and tables and perform statistical analyses, teach/train/study, advise others and carry out risk analysis. CABI's long-standing expertise in invasive species makes it ideally placed to develop this resource, in partnership with other expert organisations, such as ISSG who are key providers of biodiversity-related content to the ISC. The US Department of Agriculture is a lead partner with CABI in the project.

**Delivering Alien Invasive Species Inventories for Europe (DAISIE)**
Delivering Alien Invasive Species Inventories for Europe (DAISIE) is an example of a regional resource that provides a "one-stop shop" for information on biological invasions in Europe to help those tackling the invasive species challenge. The general objectives of DAISIE are to create an inventory of invasive species that threaten European terrestrial, fresh-water and marine environments, to structure the inventory to provide the basis for prevention and control of biological invasions through the understanding of the environmental, social, economic and other factors involved, to assess and summarise the ecological, economic and health risks and impacts of the most widespread and/or noxious invasive species, and to use distribution data and the experiences of the individual Member States as a framework for considering indicators for early warning. It is possible to search DAISIE for information on 8,996 alien species occurring in Europe, or one of the 1598 experts on biological invasions in Europe, or search regions to explore the alien species threats across Europe, for 63 countries/regions (including islands) and 39 coastal and marine areas. Accounts for these species provide information on their biology and ecology, habitat and distributions (including detailed maps), introduction pathways, invasion trends, impacts and management methods including ways of prevention.

**Inter-American Biodiversity Information Network's (IABIN) I3N**
I3N is the invasive species thematic network of the Inter-American Biodiversity Information Network (IABIN). I3N is using World Bank GEF funds to promote the standardization of invasive species information tools in the western hemisphere. The National Biological Information Infrastructure coordinates I3N, but Sergio Zalba (Argentina) and Silvia Ziller (Brazil) are the developers and trainers in the use of I3N tools. I3N will share the tools (Access database, Microsoft Server Web template, and manuals in Spanish, English, or Portuguese) with anyone who requests them, but so far has funding to provide help desk support only to I3N member countries (in the Americas). I3N's latest addition to the suite of freely-available tools is a beta Spanish version of a Risk Assessment and Pathway Analysis Tool in Microsoft Excel, with manuals and a PowerPoint presentation, freely downloadable. English and Portuguese versions are in development. These tools are designed to work using the information provided in the I3N information systems and to help decision makers prioritize their response to invasive alien species.

**Aliens-L and other list servers**
A helpful contribution to information exchange on invasive alien species can be achieved through the use of list servers. For example, a message posted on the well-established Aliens-L list server along the lines of "there is some deliberation about plans to use alien species 'X' for purpose 'Y' in our country or region" will usually flush out several responses if the species in question has been problematic elsewhere. 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. List servers may be lacking in some aspects of consistency, standardisation, and quality control, but they offer an important contribution to empowerment and horizontal information transfer (e.g. practitioners helping each other and others) because of their great flexibility and their ability to deal quickly with ad-hoc, time-critical issues.

**The Conservation Commons**
The IUCN SSC Invasive Species Specialist Group and the National Biological Information Infrastructure (NBII) are amongst those organisations who have formally endorsed the Principles of the Conservation Commons, which works to remove barriers to the free flow of information related to biodiversity conservation. The Conservation Commons promotes the principles of open access, mutual benefit and fair use. Users of the Conservation Commons are expected to comply, in good faith, with terms of uses specified by contributors and in accordance with these principles.

**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.

Information exchange is needed for all stages of management of invasive alien species, from risk analysis and prevention to eradication, containment and control. It is also needed at all levels: local, national, regional, and global. Clear synergies exist between the concept of pre-import risk screening and the availability of information about biological invasions to allow officials to conduct screening in a timely fashion. The tools described here operate at the global and regional scale, and have particular relevance for early warning and risk analysis. These tools are supported by thousands of expert contributors and a very broad user community. A relatively modest ongoing investment in existing global-scale information exchange systems would quickly provide the world with access to information about the majority of known invaders.

# 5. EXAMPLES OF NATIONAL APPROACHES

Regulation of wildlife and introduced species varies greatly from country to country, and also within regions, territories, provinces and states (see review by Pitt and Witmer 2006).Several nations, such as Australia and New Zealand, have created proactive regulatory programmes that have successfully reduced alien species introductions (DW 2007).

Often, funding for research, prevention, control and eradication is low prior to an invasive species becoming established and widespread, and only secured when public support is pressuring public officials. After the species is established and causing damages and economic losses, public interest increases, however, the costs of control skyrocket and the probability of success drops (Pitt and Witmer 2006).

A list of the submissions used to compile this information is listed in Annex 1. In addition, short papers (cited in text) from the Expert Workshop on Live Animal Imports, held at the University of Notre Dame, Indiana, in April 2008, as well as other sources of information were used to describe national approaches and regulations.

All data included below is taken from the submission of the country to the CBD unless otherwise indicated.

## 5.1. AUSTRALIA: PRE-IMPORT SCREENING AND REGULATION OF LIVE ANIMALS FOR IMPORT

*(Information from two different submissions from Australia)*

The Australian Biosecurity system for primary production and the environment (AusBIOSEC) is the main framework that brings together biosecurity activities undertaken by the Australian government, state and territory governments, industry, landholders and key stakeholders in primary production and the environment (Gascoigne, 2008). AusBIOSEC's scope covers prevention to pre-border assessment and border control, emergency response and management of established invasive species. Within this framework, the Australian Pest Animal Strategy (DEWHA 2007) was developed to address undesirable impacts caused by exotic vertebrate animals and prevent the established of new exotic vertebrate species (Gascoigne 2008).

Biosecurity Australia undertakes import risk analyses and provides policy advice. The Australian Quarantine and Inspection Service (AQIS) provides policy advice for imports in conjunction with the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act has a "black list" of species that cannot be legally imported into Australia. The list can be amended and the applicant is required to submit an assessment of the potential impacts on the Australian environment of this proposed amendment (Gascoigne 2008).

The Invasive Animals Cooperative Research Centre (IA CRC) is a cooperative venture between government, universities and private enterprises to develop, create and apply solutions for pest animal problems in Australia. IA CRC comprises 41 member organisations and has been operating since 2005. A key project has been developing and validating risk assessment models to assess the potential for an exotic vertebrate to establish or become a pest in Australia. The Bureau of Rural Sciences in the Australian Department of Agriculture, Fisheries & Forestry has developed risk assessment models which have been endorsed by the National Vertebrate Pests Committee and may be used as the basis for future exotic species import applications.

These models are currently being used by the Australian Government and by a number of state governments in Australia. As part of IA CRC's project, the Western Australian Department of Agriculture and Food are using the models to assess the pest risk posed by 40 vertebrates, some of which are already present. These models will provide a robust system for screening potential imports or assessing exotic species already in Australia. The models have recently been refined and the final report is available at the link below:
http://www.invasiveanimals.com/publications/downloads/Risk-Assessment-Models-report-FINAL.pdf

Further information can be found at: http://www.feral.org.au/content/policy/risk.cfm

With the Bureau of Rural Sciences, the Invasive Animals Cooperative Research Centre is developing CLIMATCH climate-matching software for use with updated risk assessment models (http://www.brs.gov.au/climatch).

## 5.2. BRAZIL: ACTIONS AND REGULATIONS FOR LIVE ANIMAL IMPORTS AND PET RELEASE PATHWAY

Brazil's Invasive Alien Species National Survey indicates that 10% of the species currently registered in the Invasive Alien Species National Database have been introduced for ornamental purposes and as pets. Examples commonly found in pet shops include the red eared slider terrapin (*Trachemys scripta elegans*), the Siamese fighting fish (*Betta splendens*), the red swamp crayfish (*Procambarus clarkii*), the bullfrog (*Rana catesbeiana*) and the African clawed frog (*Xenopus laevis*). The breeding and sale of red-eared sliders and the African clawed frogs are prohibited by law, under article 29 of the Environmental Crime Laws.

Wildlife smuggling is also considered a crime according to environmental law. The Nature Conservancy (TNC), the Horus Institute, Renctas (Nationwide Network Against Wildlife Smuggling) and the General Fauna Coordination of the Federal Environmental Agency in Brazil are leading an initiative to inform pet store owners, veterinarians and consumers about the risks associated with the release of pets into the wild. There are also voluntary codes of conduct available for the pet trade in Brazil.

Brazil has recently published new legislation for the ornamental fish trade, including a new quota for stingrays, and a list of freshwater and marine fish species permitted for export.

## 5.3. CZECH REPUBLIC: REGULATIONS FOR ANIMAL IMPORTS

There is no legislation or comprehensive strategy in the Czech Republic which explicitly addresses risks associated with the introduction of alien species as pets, aquarium and terrarium species, live bait and live food. While invasive species are not yet a serious problem, potentially due to the local climate, one species which has posed problems is the red-eared slider turtle (*Trachemys scripta*), an omnivorous organism that has been introduced around the world through the pet trade (Pitt and Witmer 2007), which may compete with native turtles, prey on invertebrates and occasionally on birds and forage on native vegetation (Pitt and Witmer 2007).

Main regulations used to prevent the transport and introduction of invasive alien species are CITES and the European Commission Regulation 811/2008/EC (suspending the introduction of certain species of wild flora and fauna), and the national Act on the Protection of Nature and Landscape Areas No114/92, where the intentional dispersion of alien plant and animal species of invasive alien species is prohibited without special permission from a nature protection authority in protected landscape areas, national parks, national nature reserves and nature reserves.

## 5.4. ESTONIA: BEST PRACTICES ADDRESSING THE INTRODUCTION OF ALIEN SPECIES AS PETS, AQUARIUM AND TERRARIUM SPECIES

The Environmental Inspectorate is the authority responsible for surveillance, investigations and fines for those found guilty of importing "black list" species. Some species are forbidden to import under the Nature Protection Law. Information about specific problematic invasive species introduced via the pet industry can be found below:

***Chinese sleeper* (Perccottus glenii)**

Chinese sleeper (*Perccottus glenii*) has been found in some water bodies in north-eastern Estonia due to release from aquariums. Chinese sleeper is a hardy fish and a generalist feeder that is known to severely affect aquatic ecosystems, especially by damaging amphibian populations. It was first discovered in 2005 in a pond near the Narva water reserve. A more thorough investigation revealed more than 200 specimens in the pond and a lower density in a nearby water channel and in the Narva water reserve.

Efforts to eradicate Chinese sleepers included nets and electricity, however full eradication was not achieved. Poisons could not be utilized as the aquatic systems are highly connected. A pilot project was initiated where carnivorous northern pike (*Esox lucius*) were released into the pond. The numbers of Chinese sleepers have decreased significantly as a consequence. The pilot project is still ongoing .

***Alien Crayfish***

Import of live specimens of narrow-clawed crayfish (*Astacus leptodactylus*), spinycheek crayfish (*Orconectes limosus*) and signal crayfish (*Pacifastacus leninculus*) is forbidden and these species are on the "black list". These alien crayfish are much more successful in nature compared to the native noble crayfish (Astacus astacus). The alien crayfish grow faster, mature earlier, are more fertile and have a better resistance to crayfish plague (*Aphanomyces astaci*), in addition to carrying and spreading the disease. There have been cases of the narrow-clawed crayfish being sold as live food.

***Alien terrarium species***

Red-eared sliders and yellowbelly sliders are sold in pet shops. It is not known if these turtles can breed in the wild in Estonia. However, public education activities have been initiated by a group of exotic pet enthusiasts, such as members of the Baltic Herpetological society, to help reduce exotic pet abandonment.

## 5.5. ISRAEL: ADDRESSING THE IMPORT OF VERTEBRATES TO PREVENT INVASIVE SPECIES

Since Israel's foundation in 1948, 22 species of exotic terrestrial vertebrates have become established (Hatzofe and Nemtzov, 2004). Four of these were released via the pet industry (Burgiel et al. 2006).

The Israel Nature and Parks Authority (INPA) works to prevent any future invasions of wildlife, using border controls, enforcement of conditions for keeping exotic wildlife, public education, fast response for capturing escaped animals, and a risk assessment programme for new imports (Nemtzov 2008). The responsibility for aquatic species, invertebrates and plants falls under a separate government agency (Nemtzov 2008).

The system for risk assessments established in the late 1990s was based on a simplified Australian system (Nemtzov 2008). When an IPNA import permit is requested, a risk assessment is conducted by gathering detailed biological information on the species via a set of questions, as follows (from Nemtzov 2008):

- Could the species survive and breed in Israel's climate?
- What does the species have to eat all year round in Israel?
- Has this species (or a close relative) invaded successfully elsewhere?
- Could the species hybridize with any Israeli species?
- Could this species pose a threat to agriculture, human health, or other species or ecosystems in Israel?
- Could this species provide any benefit to humans or nature if it became established in the wild in Israel?
- Would it be feasible to eradicate it if it were to become established in the wild?

The qualitative information is used to prepare an initial scientific opinion and one of 3 risk categories: Low, Medium, or High Risk. Species that have previously invaded habitats similar to those in Israel (especially Mediterranean ecosystems) are classified as High Risk. The initial risk assessment data are refereed by three ecologists, and the species' risk category is finally decided upon by consensus. There is an opportunity for public feedback via an annual Internet-based public hearing. Comments are assessed and may result in changes to a species' risk category (Nemtzov 2008).

Israel generally functions according to the White List system. All species are initially prohibited unless they have undergone a risk assessment and are classified as Low Risk. Only Low Risk species are published on the White List and are permitted for import for the pet trade. Israel's Black List contains species that have undergone a risk assessment and are classified as Medium or High Risk. Medium Risk species may only be kept in mini-zoos, or by breeders or collectors; and high Risk species may only be imported and held only at a special research or conservation institutions (such as universities and leading zoos) (Nemtzov 2008). There have been no new cases of invasive vertebrates in Israel since this risk assessment system was implemented (Nemtzov 2008).

Israel also has also reviewed reports from pet store owners and concludes that if a client does not know exactly what species they intend to buy, they will buy what is available at the pet store whether or not the species is classified as High or Low Risk. Importers generally seek to import attractive species, and marketability is not affected by the degree of risk. The INPA is working with importers and pet store owners to find attractive species that pose a Low Risk, reducing feelings of frustration from having attractive species banned.

## 5.6 JAPAN: INVASIVE ALIEN SPECIES LEGISLATION AND IMPLEMENTATION FOR INTENTIONAL ANIMAL IMPORTS

Japan imports large volumes of living animals (Mizutani 2008). In 2003, 73 million live vertebrates were brought into Japan. It is also thought that many species are unintentionally introduced into Japan along with imported goods and containers.

Japan's Invasive Alien Species Act entered into force in July 2005 to control invasive alien species and prevent ecosystem damage (Mizutani 2008). The Act applies to alien species that are recognized to or may potentially cause damage to ecosystem, human safety, and agriculture, forestry and fisheries. The followings are the main points of this Act concerning live animal imports:

- Breeding, planting, keeping or transporting invasive alien species will be prohibited unless authorized by a competent authority. Obtaining permission is a prerequisite for importing any invasive alien species. Discarding invasive alien species into the wild will not be allowed at any time.
- Before importing uncategorized alien species (UAS), alien species suspected of being invasive, importers must notify the appropriate authority of the ecological properties of the UAS. If a species brings economic benefits to an industry, it is necessary to establish a special working group among stakeholders to discuss ways to reduce the risks. Importation of the UAS will be restricted until the assessment is completed (Mizutani 2008).

In 2007, live animal imports into Japan were substantially reduced due to the enforcement of the Invasive Alien Species Act and the intensification of animal quarantine, especially for avian influenza. However, the Act does not cover the risk of infectious diseases to wild animals (Mizutani 2008).

## 5.7. MAURITIUS: ADDRESSING INTENTIONAL ANIMAL IMPORTS

Live animal imports have had significant negative impacts on native biodiversity in Mauritius, such as predation, herbivory, competition, alien seed dispersal and spread of disease (Mauremootoo 2008). The rate of live animal imports appears to be increasing and there is growing trend in the sale of exotic birds, reptiles and amphibians as pets. These animals are sold at markets, garden centres, aquariums and supermarkets. Animals sold as pets include the red-eared slider (*Trachemys scripta elegans*), the apple mystery snail (*Pomacea bridgesi*), various frog species, geckos, iguanas, chameleons, a variety of birds such as parakeets, lovebirds, grey parrots, amazons and lorikeets. Live animal imports that have become established in Mauritius include the Madagascan day gecko (*Phelsuma madagascariensis grandis*), the golden apple mystery snail and the Australian red claw crayfish (*Cherax quadricarinatus*). There are also reports of illegal imports of live animals, such as large numbers of tortoises smuggled into Mauritius for private collections (Mauremootoo 2008).

The National Invasive Species Strategy for the Republic of Mauritius (NIASS) was finalized in January 2008, in order to minimize or eliminate the negative impacts of invasive alien species on the economy, environment and society. The invasive alien species Action Plan accompanied by SMART (Specific, Measurable, Attainable, Realistic and Time bound) indicators is currently being formulated to ensure the implementation of the NIASS. The Action Plan will consist of five hierarchical "Management Elements" (Prevention, Early Detection and Rapid Response, Eradication, Control and Management and Restoration) and six "Cross-Cutting Elements" (Legal, policy and Institutional Frameworks, Capacity Building and Education, Information Management and Research, Public Awareness and Engagement, International Cooperation and Provision of Adequate Resources) (Mauremootoo 2008). At present, the Animal Diseases Act (1925) requires all importers of live animals to obtain a certificate signed by a veterinary surgeon certifying that the animal is disease-free (Mauremootoo 2008).

## 5.8. PORTUGAL: REGULATIONS FOR ANIMAL IMPORTS

Portugal's national strategy for Nature Conservation and Biodiversity (2001) contains a set of measures concerning integrated policy, scientific research, management, education and public awareness related to invasive alien species. Specific legislation has been adopted which regulates the introduction of invasive alien species (Decree-Law No. 565/99 of 21st of December). This Decree-law prohibits breeding, culture or detention in a confined space, as well as the use of ornamental plants or pets identified as invasive or those considered entailing an ecological risk. Deliberate introduction of such species is prohibited without specific authorization.

This Decree-Law is currently undergoing revision to address several issues, including the establishment of criteria of possession and safety, inclusion of additional invasive species or species with ecological risk, and the possibility of destroying apprehended specimens.

Additional legal and regulatory measures include the following:

- Lei de Bases do Ambiente (Law 11/87, 7 April 1987, Article 15, No 6) mentions the elaboration of adequate legislation regarding the introduction of exotic flora (Article 16, No. 3) and the adoption of measures to control the introduction of animal species.
- Regional Decree Do. 27/99/M regulates imports dissemination, and keeping of exotic fauna species into the Autonomous Region of Madeira.
- The autonomous Region of Azores adopted Resolution No. 148/98, of June 25th, which aims to limit the possibility of dissemination of non-native species through the escape of their specimens.

### 5.9. THAILAND: REGULATING AQUATIC ANIMAL IMPORTS

Thailand has regulated the import of aquatic animals. In order to import an aquatic species, a license must be obtained from the Institutional Biosafety Committee (IBC) of the Department of Fisheries, composed of experts and relevant government officers who research and carefully consider the proposed import. The IBC has restricted imports of species expected to be problematic in the past, including the Barcoo Grunter / Jade Perch (*Scortum baroo*) from Australia, expected to prey on small native fish, larva, and zooplankton if released, as well as sucker catfish (*Liposarcus pardalis, Pterygoplichthys* spp) which damage native fish eggs and aquatic plants and have caused population declines in economically important native species when released into natural waterways.

The import of laboratory animals is regulated by the National Laboratory Animal Centre, Mahidol University (NLAC-MU) and the Animal Epidemics Act, B.E. 2499 (1956). Most laboratory animals are alien species. Their good health must be certified by the supplier company from which they are purchased, and quarantine upon purchase confirms this. Animals are required to be destroyed once research is complete. In the case that an animal was released, it could be traced back to the importing researcher.

### 5.10. UNITED KINGDOM: RISK IDENTIFICATION AND RISK ASSESSMENT

Great Britain has developed a risk analysis mechanism to assess the risk posed by all alien species (but not including bacteria, viruses and fungi). The generic risk assessment methodology that is used was developed by a consortium led by Central Science Laboratory. The format is based on the European Plant Protection Organisation (EPPO) risk assessment methodology.

This mechanism consists of the following elements:

- Non-Native Species Secretariat, who commissions the risk assessments and peer reviews on behalf of the coordinating body for non-native species in Britain. They are responsible for the smooth running of the risk analysis mechanism.
- Risk Assessors, who are experts in the taxon that is being assessed. They complete the risk assessment and respond to comments from the Risk Analysis Panel.
- A Non-native Risk Analysis Panel, consisting of six risk assessment experts, who meet quarterly to review risk assessments. The Panel provides comments on the risk assessment to the Risk Assessor.
- Peer Reviewers, who are commissioned by the Secretariat to review the risk assessment and critically assess the use and interpretation of the literature. Their report is seen by the Risk Analysis Panel and informs their comments.

### 5.11. UNITED STATES: REGULATION OF LIVE FISH IMPORTS

More than half a million shipments of over one billion animals were imported to the US between 2000-2005 (Smith et al. 2008). Of the live animal imports, 60 per cent were aquatic organisms with fish comprising the largest part (27 per cent). Over 200 fish have been introduced to the United States due to importation. A disturbing 85 per cent of these have established breeding populations which harm native species and / or infrastructure. Poor record keeping at ports does not allow for an assessment of the diversity of fish, species-specific risk analysis, or prevention programmes (Smith et al. 2008).

The US Fish and Wildlife Service (USFWS) is responsible for record keeping, screening and releasing live animal imports (Endangered Species Act, at 16 USC 1538). Port officers can detain or refuse shipments if the required "Importation or Exportation of Fish and Wildlife" document (Form 3-177) is missing, incomplete or inaccurate

(50 Code of Federal Regulations. 14.61). New coding systems are required so that port officers can standardize, classify and organize wildlife trade data (Smith et al. 2008).

The Aquatic Nuisance Species Task Force (ANTSF) Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process provides a framework for risk assessment and risk management, however the risk management component is less developed than the risk assessment component. There are no federal laws that mandate a comprehensive assessment of wildlife imports into the US.

The USFWS is the primary agency responsible for regulating import and interstate movement of alien species. The Lacey Act (1990) is the primary law by which USFWS regulates species imports regarded as injurious to humans and natural resources. It can take years to list a species under the Lacey act and is principally based on submitted proposals and petitioning (Fowler et al. 2007 in Smith et al 2008). The majority of species deemed injurious by the Lacey act were either present or established when first listed under the Lacey Act (Smith et al. 2008).

# 6. CONCLUSION

Introduction of alien species as pets, aquarium and terrarium species, and live bait and live food is a clear gap of international regulatory framework. There are no specific international standards that address risks of invasions associated with trade in pets and aquarium species that are not pests of plants under IPPC, such as fish, reptiles, insects, or invasions associated with live bait and live food.

Best practices of national controls on import and potentially export of pets and other living species documented in chapter 5 demonstrate that collaboration between government and experts to conduct science based risk assessment with transparency is important. To conduct risk assessment further capacity development and information sharing are considered to be urged, particularly in developing countries.

In addition to a risk assessment process, appropriate legislation to prevent, manage, and control is needed. Such an approach works best when coupled with public awareness campaigns and involvement of local communities.

The development of codes of practice and the raising of public awareness, in association with the pet, aquarium and terrarium industries, could be effective approaches to avoid the introduction, release or escape of invasive alien species.

Once invasions have occurred, they must be managed in order to limit future damage. Information from the risk assessment process and from the tools described here may help in this endeavor. Eradication, although costly, has been used successfully in several instances to remove invasive species and to allow native biodiversity to recover. While eradication may be an option to consider, prevention remains the most cost-effective strategy over time.

Risk assessment is an evolving methodology that is being improved and revised continuously. Armed with adequate information and a commitment to act, the spread of invasive species into novel areas can be successfully controlled and/or prevented.

# ANNEX

## 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 (from UNEP/CBD/COP/9/INF/32/Add.1)

| 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 importation? | 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?<br>**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 the 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 |

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