Aliens: The Invasive Species Bulletin

Newsletter of the IUCN/SSC Invasive Species Specialist Group

Issue Number 28, 2009

ISSG Invasive Species Specialist Group

IUCN

SSC Species Survival Commission

ISPRA Institute for Environmental Protection and Research

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Trachemys scripta elegans (Red eared slider), one of the 100 worst world invaders.
© Photo by Riccardo Scalera

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Editorial

The newsletter you now have in your hand is the new issue of "Aliens", the newsletter of the ISSG, with a new format, and for the first time printed in Italy. I take this opportunity to warmly thank all of the people and institutions that have helped us to realise the past 27 issues of "Aliens", and in particular Landcare Research, whose support has been invaluable for the work of ISSG in the past years.

As you can see, we worked hard to revise the graphic and structure of the newsletter. But at the same time we hope we managed to maintain the soul of "Aliens", that is intended to inform on what is going on with the issues that matter, circulate new evidences of the impacts caused by invaders in the different areas of the world, and also to show case the concrete responses to biological invasions. Please let us know if you like the new bulletin and if you have suggestions or comments, as your inputs will help us make the newsletter as useful as possible for the readers.

Many people worked on this issue and we had a great collaboration between some of the people supporting me here in Rome - in particular Riccardo Scalera and Anna Alonzi – and the ISSG staff in Auckland. I want to thank the editorial department of ISPRA (the institute where I am based in Rome) that have worked with us to revise the graphic. The support of ISPRA also permitted us, for the first time, to print the newsletter in colour and to have a more attractive front cover for the bulletin. I hope that this new graphic will help us reach a wider audience of scientists, practitioners and decision makers.

One of the reasons we wanted to revise "Aliens" is that we hope our newsletter will contribute to the discussion the world community is going to have next year, when UNEP will celebrate the International Year of Biodiversity. And for the same reason we have also worked at re-designing the ISSG website *www.issg.org* which includes an interactive map to highlight what is going on in the world on invasions. The next stage of our work is to redesign and work on the potential of the Global Invasive Species Database, with the aim of supporting more decision makers and enhancing rapid responses to invasions at the global scale.

We believe that 2010 could be a crucial year for the struggle against invasive alien species, if the global community will finally put in practise the many formal commitments it has taken on this issue since 1992, and at last start to develop a stringent, coordinated and powerful global response to biological invasions. The ISSG network will surely do its best to encourage and contribute to this effort, showing how urgent it is to act, and provide the knowledge and technical tools that are needed to preserve the world's biological diversity and our own livelihood from invasions.

Piero Genovesi, ISSG Chair

News from the ISSG

ISSG Coordination meeting

The Chair of the Invasive Species Specialist Group, Piero Genovesi, recently visited Gland and met with the IUCN's Deputy Director General, Bill Jackson, the SSC Chair, Simon Stuart, Deputy Head of the Species Programme, Jean-Christophe Vie, the IUCN Secretariat's Invasive Species Coordinator, Geoffrey Howard and the Director of the Global Invasive Species Programme (GISP) Sarah Simmons, to improve coordination on invasive species issues. Priorities for future work include an upgrade and expansion of the Global Invasive Species Database, harmonization of global terminology for invasive species (also called invasive alien species, alien species and biological invasions), guidelines and protocols on invasive species prevention and management, support for national strategies on invasive species and increasing CBD attention on invasives. Invasive species have been identified as one of the most significant threats to species and as such are a very high priority for IUCN. For this reason, increased cooperation with other IUCN/SSC specialist groups will be sought.

Global Invasive Species Database

The Global Invasive Species Database (GISD) as of September 2009 features 663 invasive species profiles online; 138 interim and 525 comprehensive. Interim profiles are not global in scope and feature limited species information. Species profiles undergo a peer review process only when the information featured is comprehensive.

Ongoing projects over the 2009 to 2010 period will result in major updates for over 200 species profiles, including the '100 of the World's Worst Invasive Species'. Funding support for this upgrade has been provided by our long standing partners the US Geological Survey- National Biological Information Infrastructure (USGS-NBII) and the Forestry Bureau, Council of Agriculture, Taiwan. Ministry of Forestry, Biosecurity New Zealand (MAF-BNZ) has provided support to improve invertebrate species profiles.

Support from the Overseas Territories Environmental Programme (OTEP) will enable us to feature an additional 10 comprehensive and 80 interim profiles online. The species list will feature those of interest to the UK Overseas Territories. USGS-NBII funds will enable us to build 16 new comprehensive profiles and upgrade 16 species profiles. By mid 2010 we hope to have 800 invasive species profile online

As of 2008, the GISD has multi-language capability, and supports non-roman scripts. Collaboration and support from the Comité français de l'UICN (IUCN French Committee) facilitated this capability. A limited amount of French language content is featured on the GISD; mostly pertaining to invasive species of interest to the French Overseas Territories.

The ISSG has recently signed a Memorandum of Understanding with the Biodiversity Research Institute of *Academia Sinica* (BRCAS), Taiwan to facilitate the translation of the contents of the GISD into both Simplified and Traditional Chinese to be hosted on the GISD portal and the mirror on the BRCAS portal. 650 invasive species profiles will be translated over a period of three years. The first phase to be completed by early 2010 will complete the translation of the '100 of the World's Worst Invasive Species'.

Thematic datasets

The ISSG has undertaken to develop thematic datasets that can be used as analytical tools by stakeholders. These datasets will be made freely available on the ISSG portal.

Themes of projects under progress include threatened species on the IUCN Red List of Threatened Species impacted by at least one invasive species threat type. Another area in focus is on developing datasets of invasive species information and data on island ecosystems. A project working on the compilation of a subset of data and information of invasive species on sub-Antarctic islands has just commenced.

Preliminary discussions are ongoing on inclusion of island ecosystems related invasive species data and information layer to the Global Islands Database- an initiative that is being developed in partnership with the Government of Italy, the Secretariat of the CBD, the Global Islands Network (GIN), UNEP-World-Conservation Monitoring Centre.

Preliminary discussions on the inclusion of a layer of Ramsar sites related invasive species data and information to the Ramsar Sites Database, is also ongoing.

Cambridge meeting summary for Aliens

The Marine Conservation Sub-Committee (MC-

SC) of the Species Survival Committee (SSC) of IUCN met in Cambridge on July 7-8, 2009. This Sub-Committee is co-chaired by Yvonne Sadovy and Claudio Campagna and brings together marine interests in the SSC with a particular focus on the species remit of the Commission. The SC meets once a year and focuses on a set of priorities identified after wide consultation on key marine interests of the Specialist Groups and related programs, and IUCN Partners.

Anna Occhipinti participated on behalf of the ISSG and was invited to become a member of the MCSC for the 2009-2012 Quadriennium.

Novel issues raised in the MCSC meeting in Cambridge have been climate change, invasive species and illegal, unregulated and unreported trade. Among the initiatives typical of the MCSC commitment towards communication and outreach the volume "Adrift: tales of Ocean Fragility" is an outstanding example. The volume was presented at the meeting and is available for sale to support IUCN projects.

A new issue of the volume ADRIFT 2 was encouraged during the meeting which would cover more marine stories such as: (a) Species that build ecosystems (to link species and ecosystems and address the issue of functional extinctions), (b) Introduced species synergized by global warming impacts (Mediterranean would be a good example) (c) Bycatch of invertebrates: corals and other endangered species.

Project updates in the Pacific

Funding support from the Critical Ecosystems Partnership Fund (CEPF) for the Polynesia-Micronesia Hotspot and the Pacific Small Environmental Grant (US) of the American Embassy in Suva, Fiji will result in the ISSG developing and posting online a searchable database and resource of all invasive species and related information on the 161 Key Biodiversity Areas of the Polynesia-Micronesia Biodiversity Hotspot.

Partnership with IUCN Oceania

The ISSG Regional Office for the Pacific (ROP) serves as the Pacific node for ISSG activities. Activities of the Regional Office include a mix of projects that address ISSG's global programme of work and those that focus on the Pacific region

The ISSG Regional Office for the Pacific (ROP) and the IUCN Regional Office for Oceania are developing a synergistic mechanism for the delivery of Pacific services addressing regional invasive species issues.

This synergy will provide the basis for the integrated delivery of an invasive species program for the Pacific that falls within the ISSG mandate and program of work as well as the IUCN-ORO program of work. Overlap between the two programs will be minimized and rather a coordinated and strategic approach will be adopted.

The ISSG ROP will act as the IUCN Oceania focal point for invasive species and represent IUCN Oceania at relevant invasive species meetings. Proposals will be submitted with IUCN Oceania to implement agreed activities that contribute to the program/work plan of IUCN Oceania and help ISSG achieve its goals for the Pacific region- to mainstream and raise awareness of invasive species issues; to facilitate links and networking between practitioners, communities and experts; and to provide reliable and current invasive species data and information to decision makers and practitioners that can be used for analysis and act as decision support tools.

Pacific Invasives Partnership (PIP)

The Pacific Invasives Partnership (PIP), the combined partnership of the Pacific Invasives Initiative (PII) and Pacific Invasives Learning Network (PILN), formally merged with the Invasive Species Working Group of the Roundtable for Nature Conservation in the Pacific Islands. PIP now serves as the single coordinating body for invasive species action in the Pacific. The ISSG is a PIP partner.

Guidelines for Invasive Species Management in the Pacific

The recently published Guidelines were launched at the PIP meeting and were adopted by PIP as its guiding framework. PIP members agreed on mechanisms to ensure that their organizations and programmes reflect the priorities of Pacific island countries and territories. The Guidelines, National Biodiversity Strategies and Action Plans (NBSAPs) and National/Territorial Invasive Species Action Plans will be used for guidance by PIP members.

Copies of the Guidelines are available free to anyone working on invasive species in the region, by writing to *irc@sprep.org*. The whole document is also on the SPREP web site at: *http://www.sprep.org/att/publication/000699_RISSFinalLR.pdf*

For more information contact Shyama Pagad at *s.pagad@auckland.ac.nz*

...And other news

A gelatinous year: three gelatinous invaders off the Mediterranean coast of Israel: *Mnemiopsis leidyi, Phyllorhiza punctata, and Rhopilema nomadica*

From March to September 2009 three alien invasive gelatinous species have invaded the Mediterranean coast of Israel turning the sea into a gelatinous mass.

The American comb jelly, *Mnemiopsis leidyi,* was first noted on 3 March 2009, when a swarm interfered with the operation of a desalination plant. Throughout the spring dense populations have been recorded along the entire Israeli coast. The introduction of the zooplanktivorous *M. leidyi* to the Black Sea in the 1980s set in motion a dramatic chain of events that culminated with a crash of the sea's major fishery and losses estimated in the hundreds of millions of US dollars that secured the species a slot on the list of 100 'World's Worst' invaders. Given the severe ecological and economical harm elsewhere, the spread of *M. leidyi* to the SE Levant is of major concern.

Phyllorhiza (photo by Sima Usvyatsov, IOLR)

Each summer since the mid 1980s huge swarms of the Erythrean jellyfish *Rhopilema nomadica* have appeared along the Levantine coast. This summer its swarms were recorded from early June till August, reappearing in early September in great numbers and causing severe envenomations to unwary bathers. Some unlucky victims (like a young woman who fell off a seabike into a dense shoal of jellyfish), required hospitalization to treat a severe burning sensation, eurythema and papulovesicular eruptions.

In July *Phyllorhiza punctata* were collected off Ashdod. Examination of our collections revealed earlier unpublished records collected in 2006, in Haifa Bay. Its occurrences off Ashdod and Haifa Bay, next to the two largest harbours along the Mediterranean coast of Israel, suggests vessel-transport. It may have arrived in vessels from tropical western Atlantic ports, or in vessels arriving from Southeast Asia through the Suez Canal.

Bella S. Galil, National Institute of Oceanography, Israel Oceanographic & Limnological Research, POB 8030, Haifa 31080, Israel E-mail: *bella@ocean.org.il*

Mnemiopsis (photo by Guy Paz, IOLR)

The CIESM Jelly Watch Program: monitoring jellyfish swarms around the Mediterranean.

Jellyfish have always inhabited the Mediterranean Sea, but "jelly blooms" were rare episodes until the last eight years when massive swarms of gelatinous organisms have become a frequent sight in coastal waters. Such events are a nuisance to people, but in some cases they become a real health hazard. They are considered a pest by fishermen, as they clog nets and keep away fish. More recently, an increasing number of industrial marine cooling systems have been put temporarily out of order by jellyfish filling the underwater pipes. The resulting socio-economic impacts – both direct (tourism) and indirect (coastal development, fisheries) – are thus tangible. The apparent increase and synchrony of jellyfish outbreaks in both western and eastern basins sends an alarming ecological signal of a potential ecosystem shift towards a "gelatinous sea" to

the detriment of fish species. Although overfishing and climate change are amongst the most probable drivers, the specific causes and mechanisms are not well identified, and the lack of reference data makes any further investigation difficult.
The new CIESM Jelly Watch Programme will gather, for the first time, baseline data on the frequency and extent of jellyfish outbreaks across the Mediterranean Sea. After the initial phase involving a few countries, a common, standardized protocol will be adopted for both coastal and open sea sightings of jellyfish swarms in the whole Basin, enabling an unbiased assessment of the geographic and temporal scale of these mass events. Offshore observations will be taken aboard vessels (ferries, coastguard boats) along selected Mediterranean routes cutting across the different sub-basins. Records will be related to both field (see CIESM TransMed Programme) and satellite hydrological data (salinity, temperature and currents).

JellyWatch programme poster

In summer 2008, JellyWatch started with a launch of a pilot, citizen-based study: a poster has been produced to draw the attention of coastal users (fishermen, divers, tourists) but also ferry passengers, asking for their report of sightings of jellyfish swarms. In the poster detailed drawings illustrate species of jellyfish most commonly found in the Mediterranean, along with a list of basic questions (formulated for the non-specialist observer) on the location, type and extension of the observed swarms. Records are sent by email to key scientists who act as focal points in different regions. After accurate screening and validation of the records, data will be centralized and integrated in the CIESM Metabase.
The poster has been translated in different languages to maximise public awareness of the issue and stimulate Citizens participation in the JellyWatch Programme. The poster is being tested in Italy (with the support of CoNISMa and MARE VIVO) and will soon be distributed in Croatia and Israel.
The most important results of the JellyWatch (besides an evaluation of jellyfish presence along the 8000 km of the Italian coast), led to the first records of the alien ctenophore *Mnemiopsis leyidi* from the Western Mediterranean and to records of serious stings by the Portuguese Man o' War in the Ligurian and Thyrrenian Seas.

National JellyWatch Focal Points:
Italy - Ferdinando Boero, Univ. del Salento
Israel - Bella Galil, IOLR
Croatia - Adam Benovic, University of Zagreb

For additional information on the CIESM JellyWatch Program: *http://www.ciesm.org/marine/programs/jellywatch.htm*

New international network for island conservationists

The *islandNet* network was recently established by the Invasive Animals Cooperative Research Centre (IA CRC) with funding support from the Australian Department of Environment, Water, Heritage and the Arts, primarily to help facilitate the conservation management of Australia's offshore islands. The network aims to bring together people and organisations with a common professional interest in island conservation issues, and includes researchers, field officers, government employees, consultants, companies with commercial interests involving islands, and indigenous and island community representatives.
We are developing an information base of experience and expertise that will document: who is doing what, where, invasive species programs that have been undertaken, and the les-

sons learned from those programs. We produce a quarterly newsletter that provides snapshots of recent control programs, and current island conservation news and initiatives. An islandNet website is also being developed on the IA CRC's *www.feral.org.au* site. The site will host a resource database containing articles, reports, policy documents and images of island-related research and management.
To date, we have about 190 people subscribed from a wide range of countries, including Australia, New Zealand, United States, France, Japan, Canada and various Pacific islands.
Anyone interested in subscribing to the network, or submitting documents/images for our database or articles for our newsletter please contact Dr Elaine Murphy (email: *emurphy@doc.govt.nz*).
You can also visit the islandNet website at the following address
http://www.feral.org.au/content/IslandNet/IslandNet.cfm

Action plan on Invasive Alien Species in Denmark

This year the Danish Minister for the Environment sent out an Action Plan on Invasive Alien Species. The Action Plan gives a number of recommendations on prevention, management, monitoring, legal status, information and capacity building. The Action Plan is implementing the recommendation in the CBD guidelines and the European Strategy on Invasive Alien Species. The Action plan also has an annex listing the "worst aliens" in the country and an observation list of species having the potential to be invasive. These lists are comparable to black and grey lists known from other countries. The action plan is only available in Danish, please visit
http://www.skovognatur.dk/NR/rdonlyres/DB812145-4733-4D7F-95AA-9EB940A61D1E/0/Handlingsplanforinvasivearter2.pdf

As a follow up to the Action Plan a number of projects and initiatives have been taken. These include:
- A portal where you can register on a map where you have seen 30 IAS, see *http://www.skovognatur.dk/DyrOgPlanter/invasivearter/Indberetning/*
- *Pacifastacus leniusculus*, detection and eradication in a river system. In the project all populations of the crayfish in the river stem has been located and an eradicating project involving a number of stakeholders will follow.
- *Rosa rugosa* is very common along the Danish coastline. Eradication/management is not always received well by the public. This project will compare public acceptance of different methods for management of *Rosa rugosa* in sand dunes
- *Petasites hybridus* is forming very dense stands along small rivers. Because of the heavy shading no plant can be found under this plant. In the winter when the ground is left open erosion of soil into the river will increase. The project will test eradication/management measures.
- Information campaign to prevent the spread of *Dreissena polymorpha*
- Eradication measures of *Prunus serotina,* including grazing and cutting
- *Arion lusitanicus* is a very common snail which is very difficult to manage. To increase management success this project will identify natural enemies and identify where the snail prefers to lay its eggs.
- Due to a longer growing season, *Ambrosia artemisifolia* is able to establish in Denmark. Introduction vector is via the contamination of imported sunflower seeds. This project will (together with industry), try to stop the import of seeds through a Code of Conduct.
- Horticulture is a major vector in the introduction of new species. Together with the horticulture industry we will find ways to stop or minimize this vector for introduction through a Code of Conduct.

For more information about the projects please contact Hans Erik Svart at *hes@sns.dk*

The Danish Action Plan on Invasive Alien Species

ISPRA and the Italian initiatives on invasive alien species

The Italian Institute for Environmental Protection Research (ISPRA) is currently working on a number of initiatives on alien species at both the national and global level. Besides becoming the headquarters of the ISSG, and being the publisher of the Aliens newsletter, ISPRA will financially support the Global Invasive Species Database (GISD), which will soon be hosted in Rome, as announced early this year by the Italian Ministry of the Environment.

ISPRA report on invasive species

Following are the main activities carried out this year, or still in progress, that ISPRA have reported:

- A feasibility study for an Early Warning and Information System for alien species, realised by a group of experts led by Piero Genovesi on a contract by the European Environmental Agency, has just been completed. Different options and scenarios have been analysed in order to implement an effective Early Warning and Information System in Europe, and are currently under discussion with the services of the European Commission.
- A Committee on alien species in aquaculture, led by Giovanna Marino, has been established by the Minister of Agriculture (D.M. 339 12.12.2008), for the implementation of the Council Regulation (EC) No 708/2007 of 11 June 2007 concerning use of alien and locally absent species in aquaculture. In addition, ISPRA will be responsible for a register of introductions and translocations containing all the information relating to them and to be made available to the public.
- An Atlas on the distribution of non indigenous species in the Mediterranean is being published, together with identification tools, within a project led by Franco Andaloro and funded by the Italian Ministry of the Environment, this project is including also a Geographic Information System on alien species distribution in the Mediterranean sea, a tissues bank, an early warning system on worst species and a ballast water monitoring system.
- Following an agreement between the Council of Europe and ISPRA, a report by Roberto Crosti titled "*Biofuel crop invasiveness*" was presented at the May 2009 meeting of the Bern Convention Group of Experts on Invasive Alien Species. As a follow up, a draft recommendation on the topic has been submitted to the Standing Committee to the Bern Convention. The objective is to invite Member States to start taking precautions against the use of invasive alien species as fuel crops.
- A survey on the initiatives carried out by Italian public administrations and other bodies on invasive alien species has been established by a group of experts led by Claudio Piccini. Results were presented in a report published by ISPRA early this year entitled: "*Inventory of the initiatives aimed at preventing, monitoring and mitigating the impacts of invasive alien species in Italy*". The study has highlighted the lack of an effective prevention system, while control activities are in place to face some emergencies. The bodies that are mostly involved in the struggle against invasions are Universities, Protected Areas and Provincial Administrations.

Invasive alien species were watched by the world on the international day for biological diversity 2009

Junko Shimura

On the 22nd of May 2009 the world celebrated International Day for Biological Diversity (IDB). The IDB is proclaimed by the United Nations to increase understanding and awareness of biodiversity issues and to commemorate the adoption of the text of the Convention on Biological Diversity in 1992. The focus was made on the theme of Invasive Alien Species as a threat to biological diversity in this year.

To promote the celebration of IDB, Secretariat of the Convention on Biological Diversity (CBD) produced two booklets in collaboration with Global Invasive Species Programme and other partners. One of the booklets is for the wide range of the public in English, French and Spanish and another one is for the children and youth in English, both of which are freely available from the CBD website (*http://www.cbd.int/idb/2009/*). The United Nations Secretary-General and other leaders of the UN organisations also delivered their messages (Secretariat of the CBD 2009a) to highlight the issue of invasive alien species. At national level, the 33 Parties for the CBD and 22 organisations have celebrated the day, reportedly. Details of the events of the countries and relevant organisations are accessible from the CBD web site for IDB2009 (Secretariat of the CBD 2009b).

As the host of the next meeting of the Conference of the Parties for the CBD, Japan invited the executive secretary of the CBD at the United Nations University Institute for Advanced Studies (UNU-IAS) in Tokyo. UNU-IAS held an international symposium titled "Invasive Alien Species - Causes and Impacts". The Executive Secretary, Dr Ahmed Djoghlaf of the CBD (The United Nations University Institute for Advanced Studies 2009) and Dr. Wojtek Solarz of the IUCN and other experts on biodiversity gave lectures. In the key-note lecture, Dr Djoghlaf announced that the year 2010 is a special year for biodiversity. The United Nations designated the 2010 as International Year of Biodiversity (IYB) to draw attention to biodiversity and to encourage international action to address global importance of the implementation of the CBD. . He described that during the IYB, starting in Berlin as the current presidency of the Conference of the Parties for the CBD, and followed by UNESCO, celebrations of IYB are taken places in January 2010. Various events on biodiversity are planned at the different parts of the world throughout the year, including the meetings of COP10 and the high level segment in Nagoya, Japan. The year 2010 is also the targeted year that the world promised to reduce the rate of biodiversity loss, as called "the 2010 Biodiversity Target" (Secretariat of the CBD 2002). One of the threats to biodiversity, invasive alien species was pointed as an important issue to tackle by the

International symposium on Invasive Alien Species – Cause and Impacts held at the UNU-IAS was filled with over 300 participants in Tokyo, Japan (Photo by Koichi Goka, National Institute for Environmental Studies, Japan

wide range of sectors such as citizens, cities, academics and industries as well as states.

After the key-note lectures, the case studies in Hawaii, Indonesia, France and Japan were reported and a panel discussion followed. The panel stressed that those increased international trade and tourism were strongly driven by a human-behaviour to seek rare and exotic goods and services from the ecosystems. Such behaviour facilitates the international trade and rapid transportation of living organisms, which includes ships ballast waters and civil aviation transportations. Although each individual consumer may think that what they demanded is very small scale compare to the nature, such behaviour of welcoming the introduction of alien species, consumption of exotic live food and the enthusiasm of buying exotic pets caused spreading invasive alien species. And the impact is not only threatening biodiversity but also a huge economic loss (Pimentel 2001). The panel concluded that our lifestyle to admire exotic species in their own living room and backyard has to be changed with wise choices of livelihoods based on the correct information and knowledge on biodiversity.

Risks associated with transportation of live animals including pets were considered as a gap of international regulations. Prior to IDB2009, best practices to prevent the risks associated with live animal trade were collected at the Expert Workshop on Preventing Biological Invasions by GISP, the Invasive Species Specialist Group of the Species Survival Commission of IUCN and the Secretariat of the CBD, in collaboration with the University of Notre Dame and Defenders of Wildlife in 2008. The risk assessment approach with possible adaptation by country for the importation of live alien animal species was suggested (Simons S and De Poorter M 2009) at the workshop. The effectiveness of the suggested risk assessment is, however, largely dependent on the process taken by the decision makers at each country level.

Since 2002 when the 15 Guiding Principles for prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species (Secretariat of the CBD 2002) was adopted by the Conference of the Parties, the first principle of precautionary approach to prevent introduction of invasive alien species was taken into account by the Parties. However, countries are becoming increasingly in disastrous condition for the biodiversity, health and economy (Hulme 2007, 2008). In-

teracting effects through rising atmospheric CO2 concentrations, warmer temperatures, greater nitrogen deposition, altered disturbance regimes and increased habitat fragmentation may facilitate further invasions (Vilà et al. 2006). It is urged to establish harmonised legislation in many more countries to prevent and control the spread of invasive alien species and to develop enough capacity, especially in developing countries, to be able to take measures on increasing opportunities of introduction of alien species.

The events taken places for the IDB 2009 in the reported 33 countries are perhaps a first local step but the public can make a big difference if every person becomes aware about the causes and impacts of invasive alien species. The important message addressed on the IDB is that the life-style of reducing stress on the environment – know the local biodiversity and make wise choices when we seek biological goods and services for life – will influence the community, country and the regions, soon or later, it becomes global actions to prevent, control and mitigate the impact of invasive alien species. Those good practices presented at the occasion of IDB 2009 at the different parts of the world should help keeping the earth healthy and alive for our life, and for the life of next generation, sustainably.

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Global trends in alien reptiles and amphibians

Fred Kraus

*Interest in alien species largely tracks damage easily perceived by humans, and, hence, those taxa creating problems of human concern tend to be better studied. Among the many alien introductions that have received relatively less attention are reptiles and amphibians. A few species – such as brown treesnakes (*Boiga irregularis*), cane toads (*Rhinella marina*), and bullfrogs (*Lithobates catesbeianus*) – are well-known invasive because of the ecological damages they have caused, but most species of introduced herpetofauna are poorly studied. This is important because, of the world's >15,000 species of reptiles and amphibians, at least 678 are documented to be introduced by humans to areas outside their native ranges, and at least 322 of these have become established in >1060 occurrences around the world. But only approximately two dozen of these introductions have been studied for their ecological, economic, or human-health impacts. The diversity of damages documented from this tiny sampling of available introductions suggests that alien herpetofauna are likely to be causing a greater number of impacts than currently appreciated, but more precise quantification of the frequency of impacts awaits considerably more research. Here I briefly summarize what is currently known about how alien reptiles and amphibians are introduced, what leads to establishment success, what their documented impacts are, what management actions have been taken, and what has limited those actions so far. Most of this discussion is abstracted from a more detailed treatment of these topics (Kraus, F. 2009. Alien reptiles and amphibians: a scientific compendium and analysis. Springer Science and Business Media B.V., Dordrecht, Netherlands. 563 pp.).*

Introduction patterns and pathways

Introductions of alien herpetofauna have increased exponentially since 1850, with a doubling time of 27.25 years. The identical pattern holds for establishments – exponential growth with a doubling time of almost 27.5 years. Most species have been introduced only one or a few times, but a large number of popular species has been introduced repeatedly. Most introductions have involved species native to North America, Asia, and Europe, with far lesser numbers involving species native to other parts of the globe.

Alien reptiles and amphibians have been introduced via eleven pathways. Six of these account for the large majority of introductions: unintentional introduction via cargo shipments or nursery trade (or their shipping vessels), and intentional introduction via the pet trade, biocontrol use, food use, or for purposes that I'll term "aesthetic enjoyment". This last category typically involves someone liking the appearance of a species and introducing it in hopes of establishing a population near where they live. Five additional pathways make up the remainder of introductions but comprise a rather small portion of introductions: aquaculture, bait use, religious release, scientific research, and the zoo trade. Most of these latter categories involve deliberate release or a mix of deliberate and inadvertent release. Several of these 11 pathways revolve around two unifying themes: an aesthetic nexus that promotes the keeping of animals and their escape, release, or introduction via private owners, wholesalers, retailers, exhibitors, or zoo personnel, and a trade-goods nexus that transports animals as unintentional hitch-hikers in cargo or vehicles during the course of regional or international trade activities. The most important pathways in total number of introductions have been the pet trade and cargo shipments. However, pathway importance is not static but varies taxonomically, temporally, and geographically. Here I will focus on these patterns of variation for the six predominant pathways, but it is important to note that so-called minor pathways should not be discounted. For example, one salamander (*Ambystoma tigrinum*) has been widely used for fishing bait across the western United States, and unused animals are frequently dumped into local waterbodies, leading to a proliferation of alien pop-

Lithobates catesbeianus – Photo by Riccardo Scalera

ulations across this region that threaten with genetic contamination locally evolved relatives.

Some pathways – such as biocontrol, food, and the nursery trade – involve relatively few major groups (e.g., food releases have involved only frogs, lizards, and turtles), but, unsurprisingly, those introduced for human aesthetic enjoyment (e.g., pet trade and deliberate aesthetic releases) have involved all taxa of reptiles and amphibians. Similarly, major taxa differ in their involvement across pathways. For example, frogs and lizards have been introduced via all six major pathways, and snakes via all but the food pathway. But crocodilians have only been released via the pet trade and for personal aesthetic enjoyment; salamanders via pet trade, deliberate aesthetic release, scientific experiment, and a few cargo releases; and turtles via the pet trade, deliberate aesthetic release, biocontrol, and food pathways. Introductions of all major taxa, except for crocodilians, have been increasing exponentially since the 1850's.

Pathway importance has varied temporally, with deliberate introductions for aesthetic reasons predominating until the 1960's, since which time the pet trade has enjoyed surpassing, and increasing, importance. In recent decades, introductions via the cargo pathway and the nursery trade have continued to increase as well, but they lag far behind numbers coming from the pet trade. Biocontrol introductions largely ceased by the 1940's, and introductions for food use have largely been stagnant for decades. In the latter category, however, the invasive bullfrog continues to expand around the globe via this pathway, so declining trends for overall pathway numbers again do not necessarily signify the disappearance of threat.

Lastly, pathway importance varies geographically. Most introductions have occurred to Europe and North America, but no subpolar terrestrial region has been unaffected. Introductions to all major regions (continents and island groups) have been dominated by only one or two pathways. Introductions to most continents and to the Atlantic islands have been dominated by the pet trade, those to Australia by the cargo pathway, and those to other major oceanic regions (e.g., Caribbean, Indian Ocean islands) have involved a more even mix of pathways. Introduc-

tion growth rates have been highest in North America and Asia, with each location doubling in introduction numbers every 16.7 or 16.8 years, respectively, since 1850. Introductions to Europe, the Caribbean, and Pacific regions have increased more slowly, with doubling times in excess of 30 years.

Establishment success

Some pathways have more frequently led to successful establishment than others. In particular, the nursery trade, biocontrol releases, and introductions for food use have had much higher establishment success rates than have releases via cargo shipments, the pet trade, or deliberate aesthetic releases. This result is unsurprising because establishment is the explicit goal of biocontrol and food introductions, and these have often involved release of large numbers of individuals and the expenditure of considerable effort. Nursery-trade introductions seem likely to enjoy high success because hitch-hiking herpetofauna are travelling within habitat offering food and temperate climatic conditions. Furthermore, travel times are usually short, and shipments tend to be between areas having similar climates. All of these increase the probability of sequestered fauna surviving shipment and/or arriving in an equable climate.

Trachemys scripta elegans – Photo by Riccardo Scalera

Establishment success varies geographically, with small islands (those <6000 km^2) having more than twice the establishment success rate than do large islands (those >8000 km^2) or continents.

The reason for this success is yet uncertain. It may be that small islands receive a greater proportion of introductions from pathways having higher probabilities of establishment. Or it may be that most small islands are ecologically depauperate in reptiles and amphibians (which, as a group, do not readily colonize across marine barriers) and, thus, are more easily invaded once humans introduce those species.

Bomford et al. (2009) investigated several factors that might impact establishment success in reptiles and amphibians; they verified for these animals several trends that have been made clear in other taxa such as birds and fish. First, propagule pressure increases establishment success among alien reptile and amphibians. More-frequently introduced species have a higher probability of at least one successful establishment than do those species introduced fewer times. It seems likely that introductions involving larger numbers of released animals also have a higher probability of successful establishment, but data are not currently available to test this. Second, introduction success has varied taxonomically, with lizards and frogs being most successful at establishing populations, and with some families and genera being more prone to establishment than others. Lastly, successfully established species have a better match in climate between their native and invaded ranges than do species that have been introduced but failed to establish. A wide variety of other ecological attributes could be expected to impact establishment success in reptiles and amphibians (e.g., dietary breadth, fecundity, physiological tolerance), but these have yet to be investigated. Size of native range, which is sometimes thought to serve as a rough proxy for a species' ecological breadth, does not serve to predict establishment success in alien reptiles and amphibians, so direct use of relevant ecological parameters will be needed to more finely predict establishment likelihoods.

Impacts

Documented impacts from alien herpetofauna have been surprisingly diverse considering the relatively few populations that have been studied. However, some of these impacts are more nearly anecdotal than carefully quantified. That reflects in part the difficulty of studying impacts caused by alien herpetofauna, which often change ecological dynamics in subtler ways than do many of the better-known invasive plants, mammals, insects, or pathogens. Impacts from alien reptiles and amphibians may be grouped as ecological, evolutionary, or social. The first two may be of some conservation concern inasmuch as they affect native species and communities, the last affects humans directly. Most studies on impacts from alien herpetofauna are from the past two decades, yet the populations studied have been established for an average of 62 years (range 20–175 years). Because two-thirds of all herpetofaunal introductions have occurred in the past 60 years, it is reasonable to expect that impacts probably extend significantly beyond what is currently known and will increase in future.

Ecological effects can involve predation on, competition with, poisoning of, or introduction of disease to native species. The decimation of Guam's native forest-bird community by brown treesnakes serves as the herpetological archetype for effects from predation, but claims for predatory impacts have been widely ascribed to bullfrog introductions in the American West, and the green anole (*Anolis carolinensis*) is apparently driving several endemic insects in a diversity of orders close to extinction in the Ogasawara Islands. Competition from invasive herpetofauna has perhaps most clearly been demonstrated for the gecko *Hemidactylus frenatus*, which has been widely introduced across the tropics and has confined endemic *Nactus* geckos to relictual habitats in the small islets surrounding Mauritius. Competitive effects from alien tadpoles have been repeatedly documented in laboratory and mesocosm experiments, but have been little studied in the wild, except for bullfrogs. Claims for competition have been made for a variety of other herpetofauna, but many of these are correlational in nature – noting the decline of a native species as an alien relative expands in numbers and range – in part because of the difficulty of directly demonstrating competition in rapidly unfolding invasions. A more unusual instance of competitive displacement is that involving cane toad usurpation of burrows used by rainbow bee-eaters (*Merops ornatus*) for nesting, thereby reducing fledgling success by one-third. Cane toads are also currently the only known herpetological example of community disruption via poisoning, with a wide diversity of Australia's large squamate and mammalian predators having experienced severe population declines as toad populations expand across the northern part of that continent. Predators in other taxa remain largely unaffected, and some affected predator populations have also recovered after initial knockdown. Lastly, it has become apparent that population-altering diseases have been introduced via alien herpetofauna. *Ranavirus* has been widely introduced across the western United States with released salamanders used as bait, and bullfrogs and African clawed frogs (*Xenopus laevis*) are heavily implicated in the global spread of *Batrachochytrium* fungus, which has decimated native amphibian populations and communities worldwide.

Ecological impacts can also be more indirect. Some alien herpetofauna alter native communities by serving as food items keeping populations of other alien species abnormally high. For example, large populations of brown treesnakes are maintained on Guam by an abundance of alien lizards, allowing the snakes to continue cropping native fauna to extinction. And wholesale removal of avian insectivores from Guam has led to extremely high densities of spiders, and loss of volant frugivores is expected to

result in loss of pollinator and fruit-dispersal services to native plants. Because many reptiles and amphibians can attain high standing biomass, these species may frequently serve as nutrient sinks once established outside their native ranges, or they may increase nutrient turnover rates. Both processes can have wide ecosystem effects.

Unsurprisingly, the adaptive novelties that alien herpetofauna bring to invaded communities can result in evolutionary alterations in native species. This has been best documented in the case of cane toads in Australia, where they have induced morphological, behavioral, and physiological changes in some native snakes. Similarly, behavioral changes and increased morphological plasticity have evolved in an endemic Mallorcan frog in response to an introduced snake predator. However, the most widespread evolutionary change induced by introduced herpetofauna has been genetic alteration of native relatives via introgressive hybridization. This impact has been documented for at least 14 species of alien herpetofauna, in both temperate and tropical areas, and more examples are likely to be discerned with additional investigation.

Economic impacts from alien herpetofauna are fairly diverse but usually not large in scope. The most important have resulted from brown treesnakes on Guam, with large (and increasing) numbers of power outages caused by the snakes resulting in millions of dollars in damages each year, and devastation of the local poultry industry requiring import substitution at considerable cost. Spread of coquí frogs (*Eleutherodactylus coqui*) on Hawaii Island has been documented to result in property-value losses of US$8 million/yr because of the obnoxious, industrial-level noise they produce. Costs to nursery growers in Hawaii have resulted from plant shipments undergoing rejection because of infestation with coquí frogs. Agricultural values have also been damaged by cane toads consuming bees in Australian apiaries and dung beetles in ranchlands. More potentially serious threats are posed by a variety of imported reptiles that carry ticks that can vector heartwater disease to livestock and native ungulates. Although this potential has not yet been realized, it was taken sufficiently seriously by the United States government to ban the importation of three species of African tortoises, although it is uncertain that they represent the only risk for carrying these ticks.

Health effects are best documented for the rear-fanged brown treesnake on Guam, which has envenomated hundreds of humans – mostly infants and children – since its rapid population expansion in the 1960's. In recent years, approximately 150 envenomations require hospital treatment each year, but no human fatalities have yet been recorded. Health threats from alien snakes are likely to be more severe in coming years, however, as two species of alien vipers (*Protobothrops* spp.) expand across Okinawa, as Burmese pythons (*Python molurus*) expand across Florida, and as additional populations of venomous or massive constricting snakes become established. Health threats, though, are far greater for native wildlife, as diseases are vectored to naive native populations by alien relatives.

One final impact of some herpetofaunal introductions is widely shared with many alien invertebrates: loss of scientific knowledge. In particular, a number of the most widely distributed alien reptiles and amphibians is cryptogenic – we have no very specific idea of the geographic origins of these species because they have travelled widely with humans for a very long time. In some cases, taxonomic confusion also results because it becomes uncertain whether populations represent native forms or unique admixtures of alien introductions. This has been a problem with respect to *Anolis distichus* populations in Florida and *Trachemys* species in the Bahamas, among other examples. Lastly, as for many other invasive species, introduction of disruptive alien herpetofauna can render it impossible to understand the original dynamics that ordered a unique location's native ecology. This effect is most obvious perhaps on oceanic islands, but increasing numbers of alien reptile and amphibian populations on continents may make some of those areas increasingly vulnerable to this form of ignorance too.

Management

Effective control or eradication of established alien herpetofauna has rarely been attempted or successfully achieved, and it is probably not possible in many, perhaps most, instances. A few populations of frogs have been eradicated, but these actions seem to have been successful because populations were rather small and geographically circumscribed and because management effort was sustained for a long enough time to effect eradication. More usually, efforts to "eradicate" a population have foundered because of insufficient support to continue the project, insufficient expertise to conduct the operation correctly, or because the size of the population was initially underestimated. In general, eradicating alien herpetofauna faces two serious constraints, the first biological, the second social. Cryptic habits, high reproductive rates, and high densities characterize many reptile and amphibian species. As a result, before humans even notice that a problem exists alien herpetofauna can rapidly increase to uncontrollable numbers. This typi-

cally presents a narrow window of opportunity subsequent to incursion during which eradication might be achievable. Countering this is a diversity of social constraints – such as disbelief that alien herpetofauna merit response, public antipathy to killing vertebrates, public support for the alien fauna, or lack of appropriate control methods – that applies to many herpetofaunal invasions. These social constraints frequently delay response to new incursions beyond the point at which eradication can be achieved. The social constraints are potentially amenable to improvement, and this could eventually expand the range of taxa that might be susceptible to eradication. But the biological constraints will still likely restrict the eradication option to a minority of herpetofaunal incursions unless acted upon quickly and decisively.

These facts mean that managerial reliance on post hoc response to herpetofaunal incursions can never form the foundation of a successful program to stem these invasions. Instead, the most effective way of managing the problem is to prevent introductions from occurring in the first place. In this regard, it is important to recall that alien reptiles and amphibians are moved via both intentional and unintentional pathways, because prevention methods will vary between those two pathway modes. At present reptiles and amphibians seem to rarely be included in national quarantine regulations, although Australia and New Zealand provide obvious successful exceptions. More usually, jurisdictions adopt a laissez faire attitude that allows virtually unhindered importation of alien herpetofauna. So, by and large, existing prevention programs are woefully inadequate for stopping new invasions, and this situation needs to change. Given the massive importance of the pet trade in generating new herpetofaunal introductions, the logical means of providing the greatest control over further invasion would be to implement a screening system for proposed intentional introductions. Doing this, however, first requires development of a credible risk-assessment model for alien reptile and amphibian species, similar in concept to the widely assessed Australian weed risk-assessment system. Work on developing such a model has barely begun, with (as noted above) a few attributes identified as correlated with successful establishment but with much additional work remaining to be done. For accidental introductions, research is more properly focused on developing risk-assessment models for relevant pathways and devising effective and efficient means of treating contaminated goods for hitch-hiking herpetofauna. As one example of the latter, we have had some success in removing coquí frogs from potted nursery plants in Hawaii using a short hot-water treatment. Development of similar techniques that can be safely used on a variety of cargo could potentially limit spread of alien herpetofauna via other unintentional pathways.

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The Practicalities of Eradicating Red-eared Slider Turtles (*Trachemys scripta elegans*)

Scott O'Keeffe

*Two wild populations of Red-eared Slider Turtles (*Trachemys scripta elegans*) were identified in southeast Queensland, Australia, in 2005. Because the species is rated as a serious risk to biodiversity, but is not yet widespread or abundant in Australia, a decision was made to attempt eradication. The eradication program is a cooperative effort involving three state government agencies, local governments, landholders and some community groups. The budget for this project is small, and cooperation has been essential for success. The program uses a combination of techniques to achieve its objectives. Draining water bodies is the preferred option. Intensive trapping and netting are also used. The novel use of a detection dog to locate turtle nests and eggs allows breeding to be controlled, increasing the likelihood of success. The largest population, which occupied six small water bodies, has been successfully eradicated. This requires continuing monitoring to verify. A second small population has been reduced, but additional effort is required to complete eradication. Reliable detection of these animals is currently the greatest obstacle to successful eradication, but the development of novel DNA detection technology shows promise as a solution to this problem. The reptile trade is a potential source of animals that may be abandoned or deliberately released to the environment. An increasing illegal trade in reptiles could threaten the long-term success of this work.*

Introduction

There have been few attempts to manage Red-eared Slider Turtles (*Trachemys scripta elegans*) as a pest and there is a complete lack of published information on this species in the Australian region (Bomford 2003). Despite this, eradication of Red-eared Slider Turtles (REST) is being attempted in Queensland, Australia by a coalition of State government agencies, local governments and landholders.

So far, eradication has been conducted primarily in the peri-urban landscape in the southeastern part of the state of Queensland. Southeastern Queensland is experiencing rapid population growth. Metropolitan Brisbane is expanding into areas previously supporting small and medium-sized pastoral and horticultural enterprises, remnant forests and wetlands. These areas are being converted to rural-residential acreage and suburban housing, commercial and industrial estates, and recreational open spaces.

In January 2004 two free-ranging adult REST were found at Mango Hill just north of Brisbane, Queensland. A preliminary risk assessment of the species rated the species as an extreme risk to biodiversity, and cautioned that, based on climate tolerance, REST could potentially become established over more than half of the Australian continent. A response group representing interested government agencies and affected local governments was established to deal with the issue.

Responding to REST Sightings and Hand-ins

The response team's first priority was to gather information on the extent of the REST incursion to judge the feasibility of eradication. The team gathered information in two ways. First, comprehensive education and community engagement programmes were run in and around the Mango Hill area, where the first sliders were found. This programme was broadened to incorporate southeast Queensland, and eventually the rest of the State. A telephone 'hotline' was established, and persons having seen or captured sliders were encouraged to contact the project team. All responses were investigated, and where information suggested that sliders might be present, surveys were carried out. The surveys suggested that REST are rare, and that self-sustaining wild populations in Queensland are small.

Where any sighting was confirmed as a REST, or if a surrendered animal indicated the possibility of a wild population, still water bodies within a 2 km ra-

dius of the sighting or capture were mapped. Surveys of all water bodies in this 'buffer' were then conducted beginning with water bodies closest to the original detection. Water bodies are hand-trawled with a seine net, where conditions allow. Where obstructions or obstacles prevented seine netting, cathedral traps are used to survey water bodies. The objective of initial surveys is to establish whether a significant breeding population is present in a water body. A breeding population is indicated by the presence of multiple REST of different ages. We also treat a water body as supporting a breeding population if hatchlings, eggs or both adult male and female REST are found. The treatment strategy will then depend upon the characteristics of the water body, aquatic vegetation, and tenure of the property.

Eradication Methods

Since our investigations showed that REST are not yet abundant or widespread in Queensland, we decided to attempt eradication. The preferred method for eradication is to drain a water body, recover and relocate native fauna, remove all REST, and finally, fill and compact the site.

Figure 1. A small irrigation dam is pumped out before de-silting and REST removal - photo by Scott O'Keeffe, Queensland Department of Employment, Economic Development and Innovation

Figure one shows a small irrigation dam being cleared of REST. A caution, though- success would not have been possible without understanding the behavioural differences between native Australian freshwater turtles and REST. We found that when a water body is drained, native turtles will initially rest on the bottom or burrow only a short distance (perhaps about 40 cm) into the silt. However, we found that REST will burrow as much as 2 metres into the silt on the bottom of a water body. REST could not reliably be recovered from the substrate by shallow probing with hand tools, a method normally successful when recovering local native species.

We use an excavator to de-silt small dams. As the silt and detritus is removed, it is spread in a secure area, raked, and any REST present are removed by hand.

Disturbances in the water body provoke a characteristic response in REST. Once again, procedures that are appropriate for recovering native Australian freshwater turtles are not appropriate for removing REST. To capture local native turtles, a seine net may be run through the water while driving turtles away from banks or aquatic vegetation by splashing and beating the water. 'Beaters' drive the turtles towards the net. As the ends of the net are brought together turtles are captured in the pocket formed by the mesh. We learned by experience that this technique is unsuitable for REST. If disturbed, REST tend to drop to the bottom of the water body and burrow into the mud. Thus, if the seine net is not hauled quietly and rapidly through the water, the net will pass over the top of any REST present; they that may not emerge again for many hours. A 'noisy' survey of a water body is unreliable! Figure two shows a seine net being used to capture REST in a small farm dam.

We take advantage of other idiosyncratic REST behaviour. When a water body is drained rapidly, up to 75% of REST will emigrate (see Cash and Holberton, 2005). Before draining water bodies, we first secure sites with barrier fences and pitfall traps. This prevents emigration and allows us to use the dewatering process as a capture technique.

Figure 2. Using a seine net to capture REST - photo by Scott O'Keeffe, Queensland Department of Employment, Economic Development and Innovation

Water bodies cannot always be (1) drained, filled in and compacted, (2) drained and refilled with water or (3) netted. In the case of 1 and 2, this may be because the water body is too large, the water is required for irrigation or livestock, or the water body contains too many obstructions (logs, rocks, domestic and industrial junk).

We survey and recover REST in these water bodies with intensive trapping. "Cathedral traps" (see figure 3) are initially deployed at high density for a week.

This provides an indication as to whether a REST population is present. Although REST enter cathedral traps readily, persistent, intensive trapping is required to capture REST when small numbers are present. Basking traps were tested, but we have discontinued using them.

Figure 3. A cathedral trap for turtles. A food lure is placed in the bottom section - photo by Scott O'Keeffe, Queensland Department of Employment, Economic Development and Innovation

Deploying basking traps is very labour intensive. They are also difficult to transport, and unsuitable for use in public or high-visibility locations.

Successfully removing REST from water bodies will still leave the problem of reinfestation by hatchlings that emerge from terrestrial nests. Although eggs are usually laid close to the home water body, REST may disperse up to 2 km to lay eggs (Gibbons et al. 1983). Visual searches for turtle nests, even by trained observers, are labour intensive, and unreliable.

We solved this problem by training and deploying a detection dog and handler. The dog is able to detect REST, REST eggs, nests, and egg remains. In areas where REST are detected, the detection dog patrols the edges of water bodies. The dog can also be used to verify terrestrial sightings when exact locations are known. The detection dog allows us to reduce or eliminate breeding recruitment for REST. The dog detects REST, but leaves the nests, eggs, hatchlings and egg remains of native turtle species undisturbed.

The dog is used to patrol the edges of water bodies where REST have been detected. The dog follows the scent trails of animals leaving the water to lay eggs. In areas where nests and eggs have been previously detected, a more intensive search on a grid is carried out. Figure 4 shows the detection dog in use.

Figure 4. Using a seine net to capture REST - photo by Peter Lambert, West Australian Department of Environment and Conservation

Extent of the REST Incursion in Queensland.

Two breeding 'clusters' have been detected. A person illegally breeding REST is believed to have released several turtles to a single farm dam at Mango Hill, in about 1996. Within about ten years, these had spread to five additional adjacent water bodies. The Mango Hill population accounts for 75% of wild captured REST in this program. The breeder was apprehended and successfully prosecuted. Unfortunately we have been unable to trace all the animals distributed by this individual.

A second, smaller breeding population was detected at Burpengary, approximately 50 km north of Brisbane. At the time of discovery, two small farm dams approximately 500 metres apart were infested. REST have been removed from one of these, and four nests, three with eggs, and one with overwintering juvenile animals, were found using the detection dog. Removal of REST and infill of the second dam is imminent.

Successful breeding may also have occurred in two small lakes in a public park at Benowa, at the Gold Coast, about 100 km south of Brisbane. Following the hand-in of an adult female at Benowa recently, a search with the detection dog located the remains of some very old REST eggs. The remains of the eggs were found close to where the female was picked up. A large proportion of the REST handed in to authorities have come from the Gold Coast, an area with a large population of reptile 'collectors'. Finding a free-ranging population of REST somewhere on the Gold Coast comes as no surprise. A thorough search of the lakes has commenced, and will be completed when the lakes are drained as part of a local government remediation project.

Table 1 lists the water bodies supporting the two known populations. The table describes the water bodies, the eradication methods used in the water body, and the status of eradication. Enter the latitude and longitude in Google™ maps on your internet web browser if you want to see what the landscape looks like.

Small numbers of REST continue to be handed in by the public. Some of these are free-ranging animals that do not appear to be part of any wild population. They may be abandoned or escaped pets. Some animals are handed in without explanation as to their origin. Since it is illegal to possess REST in any Australian state, we assume that these animals have come from private collectors that wish to avoid prosecution. A small number of REST are seized by law enforcement officers each year. REST are still being imported and traded in Australia, despite publicity about the risk that REST pose to Australian fauna.

The internet encourages the illegal trade because it makes prosecution difficult. The internet offers traders a degree of anonymity, and allows trade across administrative jurisdictions. Unfortunately, the illegal reptile trade is increasing in Australia (Alacs and Georges 2008). Successfully removing free-ranging REST will not alone guarantee eradication. We must also deal with illegal traders and keepers, as they are a significant source of animals that could escape or be released to the environment.

All REST taken in the program are humanely destroyed. Post-mortem examination of these animals, particularly females, has provided us with valuable information on reproductive biology and the demography of local populations. This information has enabled us to improve our techniques, and proceed with greater certainty. For example, studying animals from the Mango Hill population has shown us that REST are less fecund than expected. Locally, they produce only single clutches of eggs, whereas within their natural distribution, five or six clutches may be laid (Ernst, Altenburg and Barbour 2006). The nesting season is prolonged, with eggs incubating from January to April, and juveniles occasionally overwintering in nests (C. Limpus, pers. comm.).

Tissue samples for DNA studies are excised from animals taken, and the remains of all animals are preserved and held by the Queensland Museum. It is possible to detect some types of cryptic aquatic vertebrates using environmental DNA. Recently, Ficetola, et al. (2008) showed that American Bullfrog (*Rana catesbiana*) can be reliably detected in water bodies using "specific primers that amplify short mitochondrial DNA sequences". We are attempting to develop a similar technique for REST. The work we have done on this so far shows great promise; if we are successful, surveillance and verification will become more reliable and much less expensive. The DNA investigations may also assist us in tracing the origins of some animals.

REST have also been sighted, handed in, or seized in other Australian states. Of these, Victoria and West Australia have established their own successful programs, with assistance from the Queensland state authorities. We have also helped local governments develop the capacity to respond to incursions of REST.

The public response to this work has been good. The issue is often reported in the media, and members of the public continue to assist by handing in REST, reporting 'unusual' turtles, and supporting our local control efforts.

For anyone contemplating a REST eradication program, we offer some important observations and cautions:

It is very important to understand the behaviour of REST under local conditions. Animals taken in any control program are a valuable source of information.
Unless you are dealing with a very limited infestation, with limited resources an eradication program will take several years.
If the REST infestation occurs in a very large water body, such as an extensive wetland or a water supply impoundment, eradication using the methods we have described is not feasible.
The methods we have used for delimitation and verification require more labour than any other component of the work. Perfecting novel detection techniques (such as detection using environmental DNA) need to be developed to reduce costs and time involved.
Sustained effort is needed. An eradication program that is not properly resourced may ultimately fail. Resources are needed for delimitation and removal of free-ranging and wild REST. But sufficient resources also need to be allocated to, monitoring and reducing the trade in these animals. Taking REST out of cyberspace may be as important as taking them out of the pond.

We are sufficiently encouraged by our results to encourage others to attempt well-planned eradication, where it is justified, and to maintain strong, cooperative relationships with other invasive species specialists with an interest in REST.

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Table 1. Water bodies supporting Red-eared Slider Turtle (*Trachemys scripta elegans*) in southeast Queensland, Australia.

	Water body	Type of Water body	Status of REST at start of program	Eradication methods used	Eradication status at site
Mango Hill Population	Halpine Dam -27.246522,153.029777	**Irrigation dam.** Very old, large, spring-fed disused. Now a conservation reserve.	Small number of animals. Breeding confirmed.	Intensive trapping and netting; use of detection dog to remove nests.	Completed. Continued monitoring of area with detection dog needed.
	Lychee 1 -27.244357,153.02187	**Irrigation pond**	Large number of animals. Breeding confirmed.	Drain, excavate and refill with water.	Completed. Water body secured with barrier (can be seen in aerial photos).
	Lychee 2 -27.244748,153.022878	**Irrigation pond**	Large number of animals. Breeding confirmed.	Drain, excavate and refill with water.	Completed. Water body secured with barrier (can be seen in aerial photos)
	Box -27.243346, 153.022503	**Livestock watering pond.** Disused	Large number of animals. Breeding confirmed.	Drain, excavate, fill in and compact.	Completed. Water body drained, excavated, in-filled and compacted.
	Raintree -27.243885, 153.022808	**Livestock watering pond.** Disused	Large number of animals. Breeding confirmed.	Drain, excavate and refill with water.	Completed. Water body drained, excavated, in-filled and compacted.
	Mineham Dam -27.245683,153.022599	**Irrigation pond.** Disused	Small number of animals. Breeding suspected.	Drain, excavate and refill with water.	Completed. Water body drained, excavated, in-filled and compacted.
Burpengary Population	Rowley-Burpengary -27.156925, 152.953747	**Livestock watering pond.** Derelict.	Small number of animals. Breeding confirmed.	Drain, excavate, fill in and compact. (proposed)	Pending
Benowa	Rosser Park, Pond, Gold Coast -28.007801, 153.384950	**Ornamental lake.** Formerly a livestock watering pond.	Uncertain. One female removed. Very old remains of 7 eggs in two nests.	Drain, excavate and refill with water.	pending- to be undertaken with complete lake remediation

Risk Assessment Guidelines for Aquatic Invasive Species in North American Inland Waters

Thomas Hammond

Although numerous introduced species provide great benefits to society, many others cause significant and often irreparable damage to ecosystems and economies in their new host countries – and impacts are increasing significantly. The Council of the Commission for Environmental Cooperation for North America (CEC) responded to this challenge with the establishment of the Tri-national Alien Invasive Species working group – with the support of national invasive species committees in Canada, the US and Mexico. The Group focused on developing Invasive Species Risk Assessment Guidelines viable for all three countries, modelled on the work of the Aquatic Nuisance Species Task Force (ANSTF) in the United States. The resulting guidelines (Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species – CEC, 2009) meet the requirements of international and regional trade conventions and agreements, and have benefited from testing on a number of organisms under real world conditions. In addition, the guidelines were developed to help inform and guide national policy, while at the same time accommodate new methodologies and processes when they become available. The article is based on the following report (Mendoza, R., Cudmore, B., Orr, R. et al. CEC, 2009):
http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=2494

Introduction

There are few environmental issues that are as well documented as the impacts of alien invasive species. The movement of people, commodities and their conveyances through international commerce along tourism has increased the risk of transfer of these unwanted organisms exponentially.

Although many non-native species provide great benefits to society as a whole a small subset of them, once established, will cause significant and often irreparable damage to the native ecosystems and economies of their new host countries. Moreover with the exception of direct habitat loss or degradation, invasive species represents the single most important near term threat to biodiversity.

As aquatic invasive species are representative of the threat potentially posed to biodiversity by international trade, the North American Invasive Species Working Group (under the auspices of the Commission for Environmental Cooperation for North America - CEC) agreed to prepare Trinational Aquatic Invasive Species Risk Assessment Guidelines.

The Working Group chose as a model the review process developed in 1996 by the Aquatic Nuisance Species Task Force (ANSTF) in the United States. The ANSTF process was straightforward, met the requirements of relevant international trade conventions and agreements, and had been already widely tested on a number of organisms under real world conditions. The resulting CEC Risk Assessment Guidelines outlined below represents a contribution to this process.

The field of AIS risk analysis is evolving quickly, however, and the CEC Risk Guidelines are designed to be flexible enough to accommodate new methodologies and processes as they become available. These guidelines, and the case study assessments upon which they are based, represent good starting point for regional cooperation on invasive species – but are not intended as the final word for national regulatory action.

Objectives of the Guidelines

The objective of these Guidelines is to provide a standardized regional process for evaluating the risk to biodiversity from the introduction of aquatic non-indigenous organisms, relevant to the existing national AIS management processes in all three North American countries.

The Guidelines were developed to function as an open process, with early and continuous input from the appropriate scientific and technical experts. They were also designed to be flexible enough to accommodate a variety of approaches in evaluating the invasive potential of introduced aquatic species - depending on available resources and accessibility of data. The Guidelines address a range of methodologies from a simple and quick professional judgmental process to an analysis encompassing extensive research and sampling technologies.

The importance of conducting a high-quality risk assessment is that it can provide a solid foundation for justifying management measures or corrective action. The specific function of the Guidelines is to present a process that can be used to: (1) evaluate recently established non-indigenous organisms, and (2) evaluate the risk associated with individual pathways for aquatic invasive species (e.g., ballast, aquaculture, aquarium trade, fish stocking, hull fouling, live bait).

Approach

The ultimate goal of the process is to produce quality risk assessments on specific invasive organisms, or to evaluate those non-indigenous organisms identified as being associated with specific pathways.

The following quality criteria (modified from Fischoff et al. 1981) were used in designing the Guidelines:

- Comprehensive – The assessment should review the subject in detail and identify sources of uncertainty in data extrapolation and measurement errors. The assessment should evaluate the quality of its own conclusions. The assessment should be flexible to accommodate new information.

- Logically Sound – The risk assessment should be up-to-date and rational, reliable, justifiable, unbiased, and sensitive to different aspects of the problem.

- Practical – A risk assessment should be commensurate with the available resources.

- Conducive to Learning – The risk assessment should have a scope sufficiently broad to carry over value for similar assessments. The risk assessment should serve as a model or template for future assessments.

- Open to Evaluation – The risk assessment should be recorded in sufficient detail and be transparent enough in its approach that it can be reviewed and challenged by qualified independent reviewers.

The assessment should be able to provide a reasonable estimation of overall risk. However, such assessments can never capture all variables. Quantitative and qualitative risk assessments should always be buffered with careful professional judgment. For instance, a risk assessment cannot determine the *acceptable* level of risk – effectively a policy decision. Moreover, assessments of yet to be introduced species cannot determine precisely whether, when, or how a particular introduced organism will become established.

Clearly, it is important to specifically describe the degree of uncertainty with regard to any AIS risk assessment process as a component of the analysis. For the purpose of these guidelines, this was defined as follows:

a) Uncertainty of the process – (methodology)

b) Uncertainty of the assessor(s) – (human error)

c) Uncertainty about the organism – (biological and environmental unknowns)

Each presents its own set of problems, however uncertainty about the organism itself is probably the most difficult to account for.

A high degree of uncertainty about the biology of a species does not necessarily equate to a significant degree of risk, although caution should be exercised with respect to those organisms that demonstrate a high degree of biological uncertainty in the assessment process. Issues of uncertainty require that the risk assessment methodologies such as these Guidelines continue to evolve when new data becomes available or new methodologies are developed.

Risk Analysis Framework

The need for a risk assessment starts either with the request for opening a new pathway that might facilitate new introductions of potentially invasive species, or the identification of an existing organism that may be of significant risk.

All pathways showing a potential for non-indigenous organism introduction should receive some degree of risk evaluation. In addition, continuous open communication between the managers and the risk assessors is important throughout the preparation of the risk assessment – ensuring that the assessment will be policy relevant when completed. Figure 1 outlines the analysis framework.

With specific reference to a “pathway” risk assess-

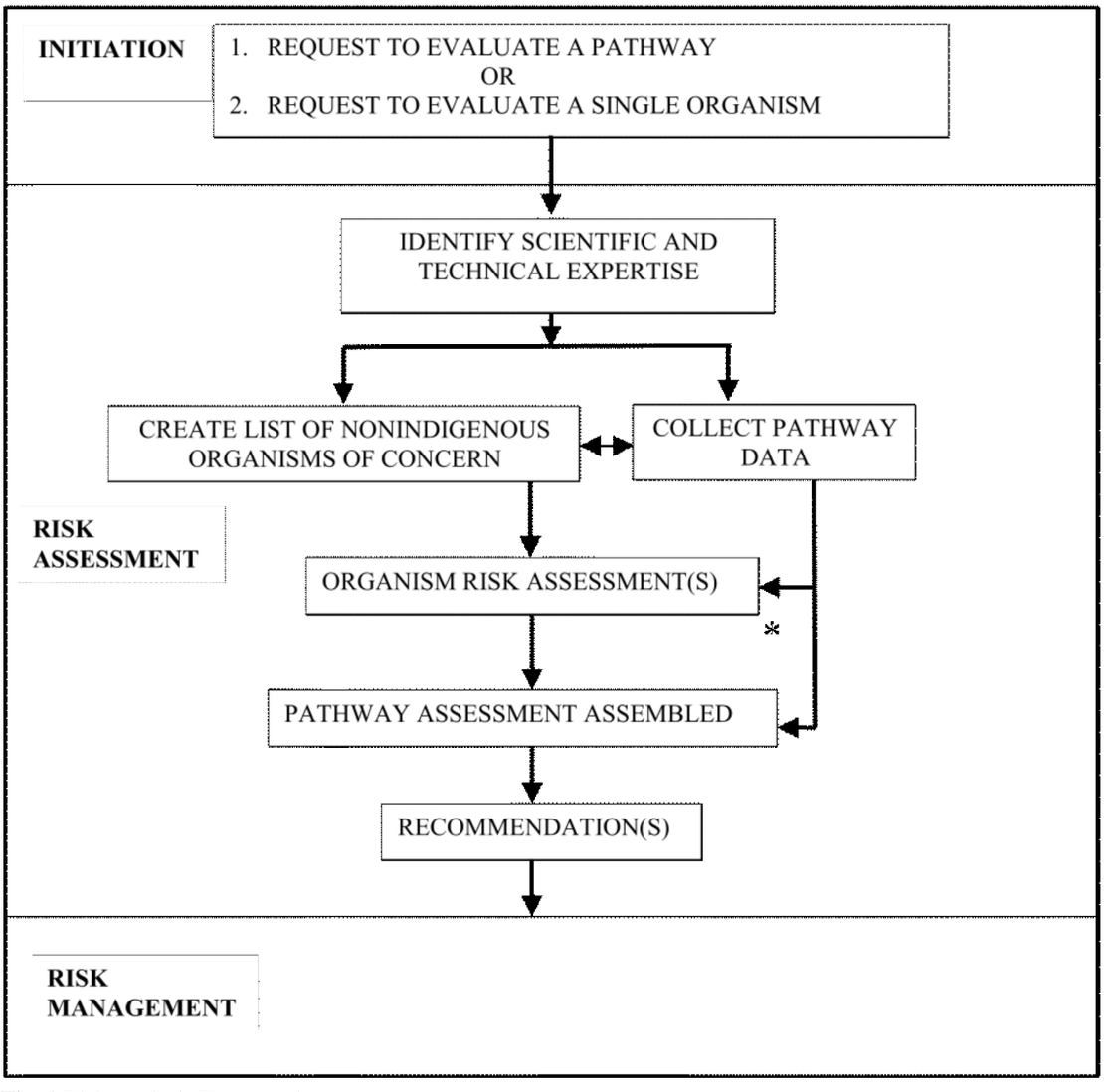


Fig. 1 Risk Analysis Framework

ment (e.g., ballast water, aquaculture, aquarium trade, fish stocking) the following generalized list of information requirements has been found to be useful in other non-indigenous risk assessments:

1) Determine exact origin(s) of organisms associated with the pathway.

2) Determine the numbers of organisms traveling within the pathway.

3) Determine intended use, or disposition, of pathway.

4) Determine mechanism and history of pathway.

5) Review history of past experiences and previous risk assessments (including foreign countries) on pathway or related pathways.

6) Review past and present mitigating actions related to the pathway.

Creating a List of Aquatic Invasive Species for Assessment

One important element identified in Figure 1 above is the need to "create a list of non-indigenous organisms of concern". To create such a list, the following generalized process is recommended:

1) Determine what organisms are associated with the pathway;

2) Screen organisms for further evaluation (Table 1 below);

3) Produce a list of the organisms of concern from step 2 above (with specific emphasis on categories 1a, 1b, 1c, and 2a). Taxonomic confusion or uncertainty should also be noted on the list;

4) Conduct organism risk assessments from the list of organisms developed in step 3.

Table 1 Screening Tool

Category	Organism Characteristics	Concern
1a	species non-indigenous, not present in country	yes
1b	species non-indigenous, in country and capable of further expansion	yes
1c	species non-indigenous, in country and reached probable limits of range, but genetically different enough to warrant concern and/or able to harbor another non-indigenous pest and/or introduce risk of hybridization	yes
1d	species non-indigenous, in country and reached probable limits of range and not exhibiting any of the other characteristics of 1c	no
2a	species indigenous, but genetically different enough to warrant concern and/or able to harbor another non-indigenous pest, and/or capable of further expansion and/or introduce risk of hybridization	yes
2b	species indigenous and not exhibiting any of the characteristics of 2a	no

Organism Risk Assessment

The Organism Risk Assessment illustrated in Figure 1 (Initiation – Point 2) is the most important component of the Guidelines used in evaluating and determining the risk associated with an individual organism. The Organism Risk Assessment can be independent of a pathway assessment if a particular non-indigenous organism needs to be evaluated. Figure 2 below represents the Risk Model that drives the Organism Risk Assessment. For model simplification, the various elements are depicted as being independent of one another. That is, the order of the elements in the model does not necessarily reflect the order of calculation.

Recording the result

Developing the final risk assessment should be flexible, recognizing the fact that each non-indigenous organism is unique and the assessor needs to have the freedom to modify the form to best represent the risk associated with that particular organism. However, the main components of the final assessment (noted below) need to be retained to best estimate risk and compare results with other assessments.

Components of the Final Assessment

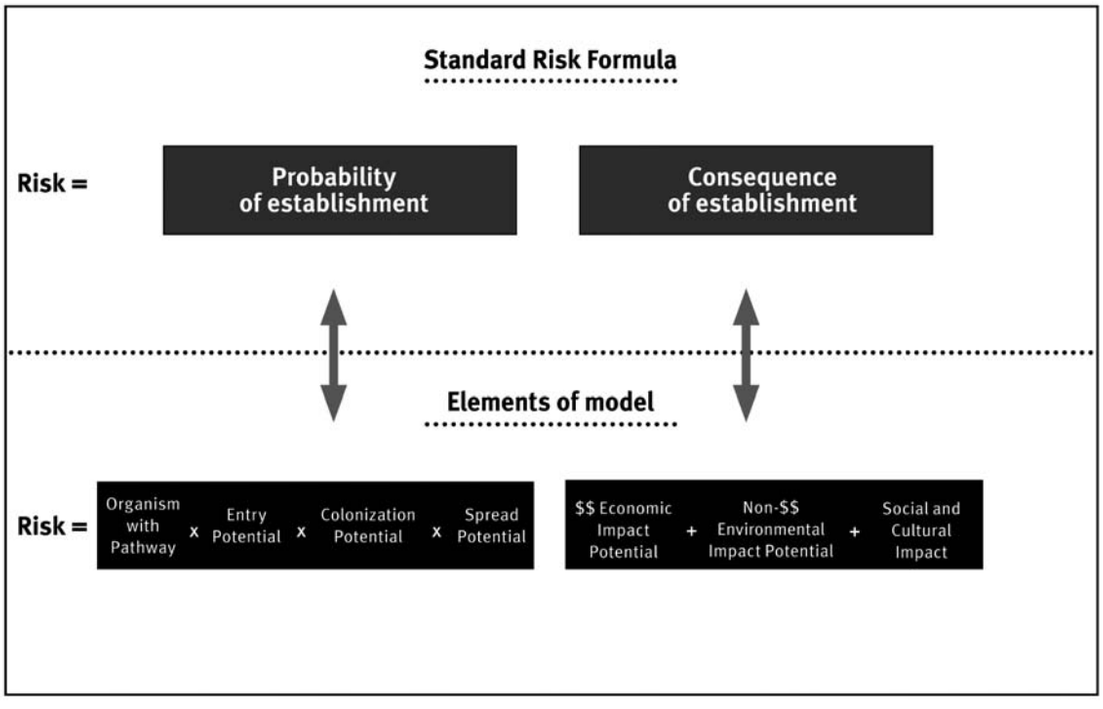
- Introduction
- Pathway information
- A complete list of the organisms of concern
- The individual Organism Risk Assessments
- Response to specific questions requested by risk managers
- Summation of the methodology used
- Summation and responses to outside reviewers

Conclusions

It is hoped that the approach to risk assessment outlined here, and set forth in greater detail in the *Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species (CEC 2009)* will prove useful to inform national policy and yet flexible enough to accommodate new methodologies and processes that may become available.

These guidelines are also available, along with risk assessments and socio-economic case studies, as *Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species: Test Cases for the Snakeheads (*Channidae*) and Armored Catfishes (*Loricariidae*) in North American Inland Waters* (CEC, 2009).

Inquiries related to these Guidelines or requests for hard copies should be directed to Thomas Hammond, Biodiversity Program Manager, Commission for Environmental Cooperation (*thammond@cec.org*).



For model simplification, the various elements are depicted as being independent of one another. That is, the order of the elements in the model does not necessarily reflect the order of calculation.

Fig. 2 Risk Assessment Model

The specific questions and rationale for the two risk assessment models addressed in this figure are listed as follows:

Group 1: Probability of Organism Establishment

- Aquatic Non-indigenous Organisms Associated with Pathway (At Origin) – Estimate probability of the organism being on, with, or in the pathway;

- Entry Potential – Estimate probability of the organism surviving transit;

- Colonization Potential – Estimate probability of the organism colonizing and establishing a reproductively viable population;

- Spread Potential – Estimate probability of the organism spreading beyond the colonized area.

Group II: Consequence of Establishment

- Economic Impact Potential;

- Environmental Impact Potential;

- Social and Cultural Influences – Estimate impact to social and cultural practices.

It should be noted that the elements considered in the Consequences box in Figure 2 can also be used to record positive impacts that a non-indigenous organism might have (e.g., its importance as a bio-control agent, pet, sport fish, scientific research organism, or its use in aquaculture). The elements in the case of deliberate introductions would record information that will be useful in determining the element-rating that provide a balance between the cost, the benefit, and the risk of introducing the non-indigenous organism.

Table 2 Case Studies

Components	**Armored Catfish (*Loricariidae*)** Focus of study – Mexico, southern US	**Case Study - Snakehead (*Channidae*)** Geographic focus of study – Canada/US
Characteristics	Originating in upper Amazon region of South America. Member of catfish family, with over 800 known species. Bony exterior "armor" plating, possessing a sub-terminal sucking mouth.	28 known species, spanning tropical/sub-tropical to temperate zones. Capable of aerial respiration; some species can survive considerable lengths of time out water, including low temperature survival. Pathways – Primarily through the live food trade. Three species of snakehead (northern, Chinese, and blotched snakehead) imported from China (Courtenay and Williams 2004).
Pathways	Very popular in the aquarium fish trade in North America, and much of the world.	
Entry Potential	Highly resistant to stresses of live transport. Significant probability of survival in many sub-tropical and tropical regions.	High, through live food and aquarium trade; Also due to the ability of this species to survive hypoxic conditions and long periods of time out of water.
Colonization Potential	Can survive a wide array of conditions and habitats, including ranges in temperature, oxygen availability, water quality, flow velocities, and severe drying conditions. Also exhibits characteristics of high fecundity and territoriality.	Significant. The northern snakehead can survive in all three North American countries; Other species can survive in Mexico and southern US.
Spread Potential	Models suggest large portions of Mexico and southern US appear vulnerable to *Loricariidae* establishment.	Significant tolerance to a wide range of environmental conditions encourages spread potential (USGS 2004).
Economic Impact Potential	Positive economic impacts resulting through the aquarium trade. Negative impacts have been reported in some areas of Mexico and US due to establishment in non-native areas.	Unknown
Environmental Impact Potential	Plowing and borrowing behavior can significantly alter conditions of lake/stream bottoms and banks. Evidence of direct food competition with native species due to bottom feed behavior – reducing food availability for freshwater insects and similar food chain species.	Voracious predatory feeding habits may significantly out compete local species (ISSG 2005).
Social & Cultural Influences	The following impacts have been recorded: • Declines in commercial and recreational fishing industries; • Damage and loss to commercial fishing nets and gear; • Weakening of stream/lake banks or retention structures due to burrowing.	Highly valued in native range for commercial and recreational fishing, aquaculture, and as aquarium fish. Also used widely for "ceremonial releases" linked to local religions – risk of similar live releases outside of native range is significant.

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Developing state strategies on invasive alien species in Brazil

Sílvia R. Ziller • Michele de Sá Dechoum

The Horus Institute is a non-profit organization from Brazil working extensively on invasive alien species issues. Since 2005, the Horus Institute, the Universidad Nacional del Sur, both I3N (IABIN thematic network for invasive alien species) Leads, the Global Invasive Species Programme (GISP) and The Nature Conservancy have reached out to 17 countries in Latin America to raise awareness, provide technical background and training, prepare and implement national databases on invasive alien species. Eight of these databases are now online (http://i3n.iabin.net), the others still in development. Seven of these countries are working on national strategies and GEF proposals to implement prevention and control of invasive species. A progress report on developing work on invasive species was prepared and presented by GISP at the 9th Meeting of the Parties of the Convention on Biological Diversity in 2008. In Brazil, three states are working intensely on developing State Strategies on invasive alien species and implementing control in protected areas. The main species under control efforts are mentioned for the different Brazilian states for reference.

Introduction

The Horus Institute was founded in March, 2002, at a time when invasive alien species was not a frequent subject in policy or science discussions in Brazil. With a mission of making economic activities and development more compatible with environmental conservation, the organization has strong focus on public awareness, capacity building and training for prevention and management, and development of legal regulations and public policies.
Following a regional workshop held in Brazil by the Global Invasive Species Programme (GISP) in 2001 and directives of the Convention on Biological Diversity, the Brazilian Ministry of Environment promoted national surveys on invasive alien species between 2004 and 2005. At this time the Horus Institute was named the Lead for the I3N – IABIN (InterAmerican Biodiversity Information Network) invasive species thematic network in Brazil and developed a database in collaboration with Dr. Sergio Zalba of the Universidad Nacional del Sur in Argentina. This model database was then disseminated throughout Latin America and is currently online in Argentina, Brazil, Paraguay, Uruguay, Colombia, Jamaica, Costa Rica, and in development in Ecuador, Chile, Bolivia, Peru, Venezuela, Suriname, Honduras, Guatemala, and in the Dominican Republic. All these countries hosted national workshops on invasive alien species science and training for adoption of the database. More information can be gathered at *http://i3n.iabin.net* or through *http://i3n.institutohorus.org.br*, where the links point to the country databases.
As a result of more awareness, national strategies are in development in Colombia, Brazil, Peru, Uruguay, and Chile, while Ecuador and Panama are developing proposals for funding to the GEF.

Brazil National Strategy on Invasive Alien Species

The Brazil Ministry of Environment is developing a National Strategy on invasive alien species to be approved by the National Commission on Biodiversity (CONABIO), in charge of implementing the recommendations of the Convention on Biological Diversity. The document is currently under evaluation by the Technical Working Group on Invasive Alien Species created to provide support to the CONABIO, composed by the Ministries of Agriculture, Fisheries and several others, as well as federal agencies and NGOs. The strategy is to be sent for evaluation and approval by CONABIO still in 2009, and then made official. The Ministry of Environment signed a Memorandum of Understanding with the Global Invasive Species Programme (GISP) in 2006 and this is one of the objectives to be accomplished with support from GISP.

State Strategies and Programs on Invasive Alien Species

Apart from providing support to the Ministry of Environment in the development of the National Strategy through GISP, the Horus Institute is working with a number of states in Brazil to raise the profile of the issue. Activities involve capacity building and field practices, writing the strategies, legal regulations and, in the lack of a national reference so far, official species lists at the state level.

Parana

The state of Parana was the first to develop and adopt a State Strategy and an official list of species in 2007. The state environmental agency (IAP) trained a number of protected area managers and other state technical staff on the topic, and started working on control in protected areas. The Vila Velha State Park, which protects some 3,000 hectares of temperate grasslands and araucaria forests, was chosen to be a model park implementing invasive species control, and the agency requested support from the state association of forest companies to remove invasive pines used by the industry from the park natural areas. In 70 days, 12 men removed about 600,000 invasive trees from the park, at a cost of US $ 40,000. About 90% of these were invasive pines (*Pinus elliottii* and *P. taeda*) coming from nearby plantations and from old trees planted in the 1960s and 70s along the highway that crosses the park. Other species removed were black wattle *Acacia mearnsii*, china berry *Melia azedarach*, pearl acacia *Acacia podalyriifolia*, tree privet *Ligustrum lucidum*, japanese cherry *Hovenia dulcis*, loquat *Eriobotrya japonica*, gums *Eucalyptus* spp. and species native to other ecosystems in Brazil aleluia *Senna macranthera* and angico *Anadenanthera colubrina*, formerly used for ornamental purposes. The greater challenge in the park is to effectively control African grasses such as *Urochloa brizantha* and molasses grass *Melinis minutiflora*.

Control (ringbarking) of jackfruit – Photo by Horus Institute

The environmental agency established a Management Committee for the State Program, composed of the Secretaries of Environment, Agriculture, Health and Education, the Federal Environmental Agencies IBAMA and ICMBio, the Horus Institute and two local NGOs, SPVS and Mater Natura. The Committee is now detailing executive plans for the Program, also taking up internal agendas according to each one's competencies and responsibilities. Health agents and teachers will receive training on

invasive alien species to help disseminate information on their concepts and impacts to the general public. The swine flu (influenza H1N1) has struck the South of Brazil quite strongly and dengue is a recurrent problem, so community agents visit homes to provide information to the public on prevention measures to avoid these diseases. Hopefully they will add the concept of invasive alien species to the information provided, enhancing the knowledge of the topic and giving many non-native diseases a common name.

The state environmental agency has published specific legal regulations to prohibit the production of invasive alien species in public nurseries, drop the need for permits to cut down invasive trees, establish obligations for the control or eradication of invasive species in protected areas, and review an official list every two years. A second version of the official list is in process of publication with categories defining prohibition or restricted management for species used in commercial production.

A technical group established by the state environmental agency built emergency control plans for some invasive animal species such as feral pig *Sus scrofa*, red-eared slider *Trachemys scripta*, common marmoset *Callithrix jacchus* and european hare *Lepus europaeus*. The agency is now raising funds to implement these plans.

Espirito Santo

The state of Espirito Santo lies in the Southeast of Brazil, mostly covered in Atlantic Forest. In 2007, the state environmental agency (IEMA) provided training to protected area managers at the state, federal and municipal levels through the Horus Institute. Staff of the state protected areas was taken to field practices repeatedly within the year to learn methods of chemical and mechanical control. The state Manager of Natural Resources consolidated control as a routine practice in the protected areas by implementing specific control plans written for each of these areas, and the state now serves as a model to others. Species commonly invasive in the region are *Terminalia cattapa*, *Acacia mangium*, *Acacia auriculiformis,* african oil palm *Elaeis guineensis*, *Syzygium cuminii*, guava *Psidium guajava*, *Mimosa ceasalpiniifolia*, butterfly pea tree *Clitoria fairchildiana*, jackfruit *Artocarpus heterophyllus, Leucaena leucocephala,* mountain-hemp *Furcraea foetida, Australian pine Casuarina equisetifolia*, castor bean *Ricinus communis*, *Tradescantia zebrina, Eryobotria japonica* and African grasses such as *Urochloa brizantha*, *U. maxima* and molasses grass *Melinis minutiflora*.

A van just reformed by the Santa Catarina state agency for the environment – Photo by Horus Institute

Santa Catarina

The state of Santa Catarina, in the South of Brazil, started working on invasive species by providing training to protected area managers at the state, federal and municipal levels, through the Horus Institute, in 2008. Control plans were written for the 10 protected areas the state environmental agency (FATMA) is in charge of, plus for one federal area, one private reserve, and three municipal areas. Some areas have only a few invasive species and small invasions, and are quite manageable with present resources and staff. Others have large occurrences of invasion, mainly by pines *Pinus elliottii* and *P. taeda*, japanese cherry *Hovenia dulcis*, australian pine *Casuarina equisetifolia*, loquat *Eriobotrya japonica*, tree privet *Ligustrum lucidum*, and African grasses in the genus *Urochloa*. A technical group was created in the state environmental agency to move the issue forward, and a field day per month established to allow protected area managers and other staff to acquire more practice in controlling invasive species.

In 2009, the state agency decided to invest in developing a State Program with support from the Horus Institute. To disseminate the concept and the impacts of invasive species, seven seminars are scheduled to take place in September and October, then a state seminar in November. This last event should be used to consolidate the activities and text in the State Program. A meeting of experts to consolidate a state official list is also to take place in November, closing the year with two important products.

Sao Paulo

The state of Sao Paulo, in the Southeast, holds remnants of Atlantic Forest, araucaria forest, and seasonal forest, besides small areas of savanna. It is the most industrialized, developed and deforested state in Brazil. In 2009, a Working Group was established at the request of the State Secretary of the Environment to produce a proposal for a state strategy on invasive species, including an official list. Two state seminars were held in August, one with experts to consolidate the list, and a second one to review and define priority activities to compose the state strategy. The strategy and official list are due in October, 2009, for presentation to the Secretary of Environment, approval and publication. Next steps include training for control in protected areas, not yet started in the state.

Hedychium coronarium, Parque Estadual do Aguaí in Santa Catarina state– Photo by Horus Institute

Pernambuco

Training for protected area managers and professionals in environmental science was provided by The Horus Institute in 2009, with support from The Nature Conservancy. Since then, the state of Pernambuco, in the Northeast, has decided to make this a priority in their conservation work, and is currently moving on to creating a species list, a model control plan for one protected area, and to begin working on a state strategy.

The state of Pernambuco is a pioneer in including specific restrictions for the introduction and for compulsory management and/or eradication of invasive alien species in their State Protected Area System legislation. The state policy on Biodiversity has established the need for the development of a state strategy.

Other states

The state of Tocantins received training for protected area managers in 2008 through The Nature Conservancy's South America Invasive Species Program, as well as the state of Rio de Janeiro. The latter is currently working on an official list of invasive species.

Challenges

Permits for herbicide use have been requested to IBAMA (Ministry of Environment), ANVISA (Ministry of Health) and MAPA (Ministry of Agriculture), all in charge of the registration of herbicides at the national level, as there are no specific herbicides in Brazil for use in non-agricultural and other production areas. The Horus Institute has established cooperation with a herbicide producer company and the Federal Environmental Agency to solve this problem. Although active ingredients are registered in the country under different commercial names, they are all indicated for use only in agricultural, forestry or other production areas. Herbicides are for this reason often understood as illegal for use in natural areas, so a few of these active ingredients will be registered for use in non-agricultural areas and indicated for the control of a number of invasive alien species. This should mean a remarkable change in the frequent resistance to the use of herbicides in natural areas, and lower the risk of legal processes for lack of understanding that these products are used as tools in the conservation of biological diversity.

Providing capacity to public managers and disseminating public information on the threat to biodiversity that arises from routine activities such as choosing plants for gardens and pets is also a challenge, but has proved worthwhile as an effort. Campaigns for the public related to pets and to ornamental plants have shown that most people are willing to replace their ornamental plants or had no idea of the damage a pet fish or turtle can do to biodiversity. A cultural change is required for native species to be valued instead of alien species, so making information accessible is quite a fundamental step.

Acknowledgements

To the I3N – IABIN thematic network on invasive alien species and The Nature Conservancy, for all the support to the national workshops. To all collaborators to the development and growth of the national databases.

Websites

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Argentina national database:
http://www.uns.edu.ar/inbiar

Brazil national database:
http://www.institutohorus.org.br

Colombia national database:
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Dealing with south Atlantic invasions: a new regional approach to invasive species

Clare Stringer

The five UK Overseas Territories (UKOTs) in the South Atlantic are home to globally unique biodiversity, and small human populations. From 2006-2009, RSPB has been coordinating an EU-funded project aimed at developing regional capacity to reduce the threat that invasive species pose to native biodiversity in the South Atlantic UKOTs. The project has involved a range of activities including collection of baseline information; developing local priorities and action plans; providing training opportunities; assessing the economic impacts of invasive species; and contributing to practical control and eradication efforts. Improving biosecurity has been a priority and changes have been implemented on several islands. A Regional Invasive Species Strategy has been developed: this will assist in guiding priorities for future work, and in establishing a more integrated South Atlantic approach to invasive species management.

Introduction

The UK has responsibility for 14 Overseas Territories (UKOTs) that are astoundingly rich in biodiversity. They are mostly small islands, and range from tropical coral atolls in the Indian and Pacific Oceans, to windswept volcanic landmasses rising from the depths of the South Atlantic. These spectacular islands are home to plants and animals that are found nowhere else on earth, and many are important seabird breeding areas (Sanders, 2006).

There are five UKOTs in the South Atlantic Ocean: Ascension Island, St Helena, Tristan da Cunha, the Falklands Islands, and South Georgia and the South Sandwich Islands. The total population of the region is around 10,000 people. There are a high number of endemic species, but also a high number of species under threat. For birds, it has been shown that the most significant threat in the South Atlantic UKOTs is the impact of invasive species (for examples see: Ryan & Cuthbert, 2008, Wanless *et al* 2009, Hall et al 2002). This is probably also true for non-avian taxa, but there is less published research to illustrate such impacts (however, see Gray *et al* 2005 for threats to Ascension's endemic flora).

Background to the project

In order to increase capacity to deal with the threat from invasive species, a project proposal was developed and submitted to the European Commission's European Development Fund (EDF-9). This "South Atlantic Invasive Species" (SAIS) project was awarded funding of some 1,900,000 over three years. It began in December 2006, and will finish at the end of 2009.The RSPB has managed the project's implementation in the five South Atlantic UKOTs on behalf of the St Helena Government. There has been a UK-based project manager and 2-3 Territory-based project officers throughout the project period. All of the UKOT governments in the region are partners in the project, along with two NGOs: Falklands Conservation and the St Helena National Trust.

The objectives of the project were:

> *Overall***:** To conserve native biodiversity and therefore enhance economic prosperity and quality of life for people living on the South Atlantic UK Overseas Territories.
>
> *Specific***:** To develop regional capacity to reduce the threat that invasive species pose to the native biodiversity of the South Atlantic UK Overseas Territories.

Establishing structures and setting priorities

For the communities living in the South Atlantic, some priority invasive species were already well known at the beginning of the project period. Many of the recognised problem species will be familiar to anyone involved in invasive species management

– rats (*Rattus rattus, Rattus norvegicus*), cats (*Felis catus*), mice (*Mus musculus*); and plants such as mesquite (*Prosopis juliflora*), gorse (*Ulex europaeus*), and wild mango or Brazilian pepper (*Schinus terebinthifolius*). However, the region does have some of its own more unusual invaders, including reindeer (*Rangifer tarandus*) on South Georgia, procumbent pearlwort (*Sagina procumbens*) on Gough Island, and calafate (*Berberis microphylla*) in the Falkland Islands.

Reindeer galloping past elephant seals, Ocean Harbour – Photo by Roger Key

Prior to the commencement of the SAIS project, a database of known non-native species in the UKOTs had been developed (Varnham 2006). The information in this document was used as the foundation for early work in the SAIS project, and illustrates the value of drawing together existing knowledge and publications in relation to invasive species and making this information publicly available. The GISD, HEAR, PIER and other online sources have also been frequently used and referred to during the project.

As the focus of the project was on building capacity and dealing with important socioeconomic as well as environmental issues, the prioritisation process was consultative. Workshops were held on each of the populated UKOTs to involve a range of stakeholders in prioritisation of issues on each Territory. Each workshop concluded with the development of a Territory-specific Action Plan setting out priorities for the project team during the duration of the project. It was important to select species not only on the basis of biological importance, but also to consider social and economic issues, and to ensure that the priorities selected were true priorities for island communities, rather than the priorities of external technical experts.

A subset of the stakeholders that attended the initial workshops on each Territory were selected as members of a local Project Steering Group. These groups met three to four times a year, with an aim of informing stakeholders of project progress and achievements, and seeking their views on revised priorities. In addition to the local groups, a Regional Advisory Group was formed with representatives of all project partners, UK governmental organisations, and international experts such as representatives of the IUCN's ISSG and the Pacific Invasives Initiative. The role of this group was to provide high-level strategic advice to the project team, and to advise on international best practice.

Filling knowledge gaps

It was recognised early in the project period that there was a lack of baseline information available, especially in relation to some taxa and habitats. To fill some of these gaps in knowledge, island-wide botanical surveys aimed at assessing the distribution of introduced plants were undertaken on St Helena and Ascension Island (Lambdon & Darlow, 2008). The surveys recorded a total of 431 higher plant species on St Helena, 365 of which are non-native. On Ascension, 248 higher plant species were recorded, with 223 of these being non-native. On both islands, more than 80% of the species present are introduced. During the survey, a lot of information on endemic plants was also collected, and one species that had not been seen for more than 200 years was rediscovered: the "neglected sedge" (*Bulbostylis neglecta*).

Bulbostylis neglecta, rediscovered – Photo by Andrew Darlow

The established flora of the Falkland Islands was better known than on Saint Helena and Ascension, and the land area of the Falklands is much larger, meaning that a botanical survey on the same scale would not be achievable. It was decided to carry

out a survey of garden and newly naturalised plants, focusing around areas of settlement and former settlement. The survey identified 28 new naturalised plant taxa, as well as recording plants that are currently only present in cultivation (Lewis 2009). In addition to the botanical survey, the pest status of many islands in the Falklands was unknown at the start of the project period (i.e. whether rodents and other pest species were present). The SAIS project has supported surveys of more than fifty islands in the Falklands to assess pest status (see Brown & Woods 2008; Passfield & Poncet 2009). During the surveys, Cobb's wrens (*Troglodytes cobbi*), listed as Vulnerable by IUCN, were found on more than ten islands where they were previously not known. Cobb's wrens cannot coexist with rats, so their distribution is limited by rodent presence (Hall et al 2002).

Cobb's wren, falkland islands – Photo by Clare Stringer, RSPB

A botanical survey of South Georgia was undertaken in 2008/09, along with a survey of invertebrates (Key & Key 2009, Osborne *et al* 2009). These surveys were aimed at assessing the distribution of introduced species, and at attempting to detect recent new arrivals. Several new or possibly new species of invertebrates were identified, but no new plant species were found on South Georgia, perhaps due to some of the thorough quarantine procedures now in place there.

Unfortunately resources did not allow a botanical survey to be carried out on Tristan da Cunha to the same scale as on the other UKOTs. Some surveys of introduced plants were carried out in 2007-08 through a project funded by the UK's Overseas Territories Environment Programme (OTEP). A report on the distribution and potential impacts of introduced species is in production (Gremmen & Halbertsma 2009).

As well as a lack of biological information, there was very little information available about the economic impacts of invasive species in the South Atlantic UKOTs. A desk-based study was undertaken to assess the impacts of invasive species, and to estimate the potential costs of priority control measures (Jenner 2009a, 2009b). This work found that the current costs of invasive species work in the South Atlantic region are more than £300,000 per annum. This cost is being borne by:

- government departments (e.g. St Helena government is spending over £250,000 per year);

- businesses (e.g. in the Falklands, earwigs are causing losses of c£7,000 per year in horticulture);
- the military (the US Air Force estimates that it spends c£20,000 per year on rodent control on Ascension); and
- private individuals (e.g. weed control on Tristan da Cunha costs the community of 265 people c£1000/year).

The impacts, ecology and abundance of introduced invertebrates remains largely unknown in the South Atlantic UKOTs, and marine invasives are similarly under-studied.

These should be priority areas for future research.

Endemic plant restoration, Ascension – Photo by Clare Stringer, RSPB

Adjusting priorities and taking action

The project Action Plans remained flexible enough to react to new information as it arrived during the project's duration. Changes were agreed with Project Steering Group members to ensure that they represented community priorities as well as the project team's views. In some cases, other funds were obtained from sources such as the OTEP and the Darwin Initiative leading to collaborations and cross-project teams. This way of working has been especially productive in the UKOTs where many people are necessarily involved in several projects at any one time.

One of the key messages that came through strongly at the action planning workshops was that people wanted to see actions being taken on the ground, rather than reports being written and published but not acted on. By contributing funds, equipment and support to existing projects (e.g. eradication of rats in the Falkland Islands, control of *Sagina procumbens* on Gough Island, control of Mexican thorn (*Prosopis juliflora*) on Ascension), the project could contribute to practical actions from the start.

In many cases, the invasive species that required control had not been recorded as invasive in other places and required the development of new and novel techniques and/or trial of techniques that had been used successfully on similar species elsewhere in the world. In particular, control trials were undertaken for whiteweed (*Austroeupatorium inulaefolium*), bilberry

(*Solanum mauritianum*) and bull grass (*Juncus tenuis*) (St Helena); calafate (Falkland Islands); wavy-leafed bittercress (*Cardamine flexuosa*) (South Georgia). The results of all trials have been recorded and passed on to Territory stakeholders. It is important that information is stored in a way where it will remain accessible after the end of the project, and where possible, data is being integrated into island-wide GIS systems.

Marking bait station grid, Tristan da Cunha – Photo by Karen Varnham

Information from the botanical surveys have already been used to inform immediate actions on Ascension Island. Following publication of the survey information, two species have been targeted for immediate eradication on the island: wild mango (*Schinus terebinthifolius*) and Indian rubber vine (*Ficus elastica*) (P. Lambdon, S. Stroud, pers. comm.). Both of these species are known to be highly invasive elsewhere in the world, so early intervention may have prevented a significant future weed problem.

Some risk assessment tools have been trialled to assist in determining priorities based on the new knowledge obtained through the project. In the Falkland Islands, an adaptation of the All-Ireland Risk Assessment (Quercus & Envirocentre 2006) was used (Whitehead 2007). This enabled a cross-taxa assessment of priorities for action in relation to invasive species, and resulted in calafate being elevated in terms of its priority for action. This species is potentially capable of transforming large areas of the Falklands landscape into shrubland, but currently occurs at serious densities only on areas of private land away from public view. Accordingly, it was not perceived to be a high-risk species until an impartial reviewer highlighted its properties. For St Helena and Ascension, the introduced plant species were assessed for "weediness" using an adapted weed risk assessment based on Owen & Scobie (1995) (Belton 2008a, 2008b).

Laying foundations for continued development

All good things must come to an end, and EU-funded projects are no exception. The project partners and project team have been conscious throughout the implementation period that it is essential to leave adequate structures in place to ensure work doesn't stop when the project ends.

Personnel from all of the Territories have undertaken training in subjects ranging from safe use of sprays and chemicals to aerial eradication techniques and diving. A wide range of skills are needed to undertaken invasive species management, and with such small populations, many Territory personnel need to be involved in numerous aspects of the process: from practical control, to fundraising and management.

On St Helena, Ascension and the Falkland Islands, weed management plans have been produced – for the first two, island-wide multi-species documents focusing on sites as well as particular problem species (Belton 2008a, 2008b, 2008c). In the Falkland Islands, plans have been produced to target calafate and gorse in particular (Belton 2008d, 2008e). Plans have been designed to complement existing site management practices wherever possible: an attempt to integrate new control measures into current workplans.


Strimmer training on Ascension – Photo by Clare Stringer, RSPB


Plant control South Georgia – Photo by Brian Summers, RSPB

For the Falkland Islands and Tristan da Cunha, new biosecurity measures have been put in place (Varnham 2008, SAIS *et al* 2009) to reduce the risks of new species becoming established. Awareness-raising and education is an important part of improving biosecurity, and building support for future control measures. Education materials featuring invasive species have been developed for all Territories with school-aged children. Awareness-raising posters and leaflets, public meetings, media articles, and newsletters have also been used to improve awareness in the general community on all Territories.

The provision of appropriate equipment and infrastructure has also been a priority. On South Georgia, the project has been able to support construction of a biosecurity store, in conjunction with OTEP and the South Georgia Government. The store will be used for checking and cleaning equipment on arrival at King Edward Point, and should assist in detecting hitch-hiking material such as seeds and invertebrates.

More basic equipment needs have also been met, with the purchase of sprayers, wood chippers, and weeding tools. Vehicles (e.g. small inflatable boats, ATVs and Land Rovers) have also been supplied on some Territories. All equipment will become the property of project partners when the project ends in December 2009, and hopefully much of this equipment will remain available for invasive species work in the future.

Tristan albatross chick – Photo by Trevor Glass

A regional plan for the future

One of the key outcomes of the project, and one that should provide a strong foundation for future invasive species work in the South Atlantic is the development of a Regional Invasive Species Strategy (RISS). This was developed following a workshop on Ascension Island in May 2009, where representatives of all South Atlantic Territory governments as well as non-governmental organisations, scientists, and international experts in invasive species management developed objectives for the region. The RISS will be used to assist in the selection of future projects and priorities, as well as raising the profile of the issue in the South Atlantic. When it has been finalised and endorsed by Territory governments, the RISS will be available from the RSPB website (*www.rspb.org.uk*), and hopefully from partner websites.

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A New Code of conduct on horticulture and invasive alien plants for Europe

Sarah Brunel

In Europe, it is estimated that 80% of the invasive alien plants are voluntarily introduced for ornamental purposes, and international trade is increasing yearly. This major pathway must be addressed urgently to prevent entry and spread of invasive alien plants, as at present, few legislation and management programs are in place. Voluntary measures to tackle the problem and raise awareness among the horticultural sector and the public are therefore considered a priority.

On the example of initiatives in the United States and in the United Kingdom, the European and Mediterranean Plant Protection Organization (EPPO) and the Council of Europe have jointly drafted a Code of conduct on horticulture and invasive alien plants for European and Mediterranean countries.

The Code of conduct and its contents

This Code of Conduct is addressed to governments and the horticultural industry and trade – plant importers, commercial nurseries, municipal nurseries, garden centres, aquarists – and to those who play a role in deciding what species are grown in particular areas such as landscape architects, municipal parks and gardens departments, recreation and leisure departments.
Its aim is to enlist the co-operation of the horticultural trade and industry and associated professionals to adopt good practices in

(a) raising awareness on this topic among professionals,

(b) preventing the spread of alien invasive species already present in Europe, and

(c) preventing the introduction of possible new plant invaders into Europe.

An outline version of this code is being developed by EPPO and is directed at national plant protection organizations.

The provisions of the Code consist in providing information and recommendation on the following points, covering all aspects of introduction, production and sale of plants:

- Be aware of which species are invasive in your area
- Know exactly what you are growing: ensure that material introduced into cultivation is correctly identified
- Be aware of regulations concerning invasive alien plants
- Work in co-operation with other stakeholders, both in the trade and the conservation and plant protection sectors
- Agree which plant species are a threat and cease to stock them or make them available
- Avoid using invasive or potentially alien plants in large scale public plantings
- Adopt good labelling practices
- Make substitutes for invasive available
- Be careful how you get rid of plant waste and dispose of unwanted stock of plants and plant-containing waste
- Adopt good production practices to avoid unintentional introduction and spread
- Engage in publicity and outreach activities
- Take into account the increased risks of alien plant invasions due to global change.

Launching the Code of conduct

This new and promising initiative requires promotion and implementation within countries. A workshop has therefore been organized by EPPO and the Council of Europe in Oslo on 2009-06-04/05 to make this code of conduct known and gather recommendations on its further implementation.

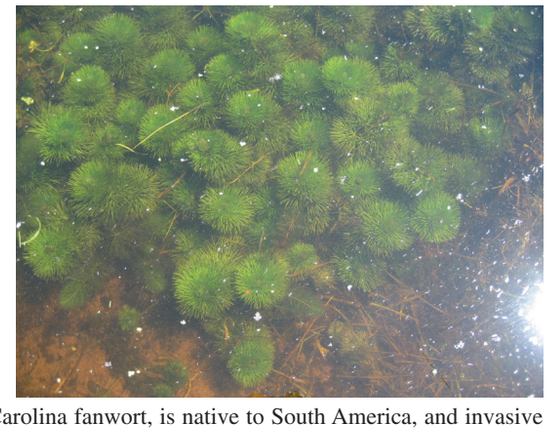
This workshop was an opportunity to hear the pro-

fessionals' opinion on this initiative through the International Association of Plants Producers (AIPH), as well as the National Plant Protection Organizations' view. These institutions are aware of the problem and willing to discuss with each other to tackle the issue, and it came out that this Code represents an opportunity for dialogue to build partnership between the different sectors involved (Government, the horticultural industry, etc). The presentations made during this workshop and list of participants are available on the EPPO website.

How to make it work?

Lessons were learnt on how a such code of conduct has been implemented in North America. Initiatives taken in the European and Mediterranean region were also presented (e.g. from Belgium, France, Italy, the UK, Spain, Sweden), focusing for instance on the selection of alternative species or on approaches at local scale with the profession.

These exchanges are summarized in a recommendation on how to draft and implement national codes of conduct on horticulture and invasive alien plants and addressed to Governments and NPPOs, to the horticultural sector, and to international organizations.



Cabomba caroliniana (Cabombaceae). The Fish grass, or Carolina fanwort, is native to South America, and invasive in Australia and Europe where it outcompetes native plants. This plant should be used only in aquariums (it is not to be used outdoors). To this regard it is important not to dispose any aquarium wastes into ponds or watercourses – Photos by Johan van Valkenburg

Sticks and carrots

Of particular interest, the recommendation encourages governments to consider regulation and voluntary approaches as complementary strategies and not self-excluding mechanisms, presenting voluntary measures as a first step that, if not successful, may lead to a regulatory approach.

As a matter of facts, when implementing such Codes of conduct, governments should particularly underline benefits and establish appropriate incentives and possible sanctions aimed to encourage the use of the Code of conduct by the horticultural industry. Examples of benefits are: benefits of being part of a private certification scheme or a group (trade association), avoidance of new more restrictive regulation, benefits in positive public image by users of Codes of conduct / damage to reputation of non-users and bad publicity for the whole industry, possible fines.

Examples of incentives and possible sanctions are: financial and tax incentives, exclusion of being part of a private certification scheme or a group, consider civil liability by importers for environmental damage.

Communicating

The communication with the public has been regarded as an essential element for the success of the code of conduct, which has not been taken enough into consideration so far. As a matter of fact, Governments should confront the wider public with the issue of IAP and people's responsibility in the choice of garden species by TV programmes, articles, field demonstrations. In this sense, they should develop the elaboration of communication material aimed at the nursery industry, the conservation sector and provide journalists with suitable information regarding IAP.

An indispensable involvement of the profession

The horticultural sector has obviously a major role to play, and should particularly:

- consider withdrawing invasive species from import, breeding or sale;
- influence the supply chain to limit or stop invasive alien plants being put on the market;
- increase the awareness on the sector's responsibility in preventing release and proliferation of IAP;
- use, promote and disseminate the Code of conduct, encourage good practices at all levels and help raise public awareness on IAP;
- look for alternative species to IAP, in particular for landscaping and gardening;
- educate staff and influence consumer choices

This Code of conduct is available in English and French, and countries such as Czech Republic, Italy and Spain are in the process of translating it in their national language.

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http://www.coe.int/t/dg4/cultureheritage/Conventions/Bern/GoE_IAS/7953-F_code%20de%20conduite.pdf

EPPO Website - EPPO / Council of Europe Workshop 'Code of conduct on horticulture and invasive alien plants'

http://archives.eppo.org/MEETINGS/2009_conferences/conf_codeofconduct.htm#pres

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EMAPI 10 - “Effective intervention through enhanced collaboration”

Llewellyn C. Foxcroft & Jan Pergl

The 10th conference on the *Ecology and Management of Alien Plant Invasions* (EMAPi) invaded South Africa seventeen years after its establishment, where it moved from its traditional regions in Europe and North America. The EMAPi conference series has become the premier international forum for communication between invasive plant management, decision making and scientific research in the field of non-native plant invasions.

The story of EMAPi meetings and cooperation began with the *International Workshop on the Ecology and Management of Invasive Riparian and Aquatic Plants* held at Loughborough University in the U.K. in 1992. The following year continued with EMAPi 2 in the Czech Republic (1993). Since then, EMAPi conferences have been held every two years across North America and Europe (Arizona, Germany, Sardinia, the United Kingdom, Florida, Poland and Australia). As EMAPi conferences have been somewhat influential in shaping the research agenda for the study of plant invasions worldwide, its status as a premier international forum has led to the number of participants increasing substantially. Not only the conferences themselves have built-up the reputation of EMAPi, but also the proceedings published as edited books or special issues of journals. The initial focus of EMAPi on Europe quickly extended to North America and other parts of the World which later led to EMAPi becoming truly global in its reach, making unique worldwide connections between managers and researchers.

The 10th conference in the *EMAPi* series was held in Stellenbosch, South Africa, in August 2009 and was hosted by the now world renowned working group on invasive species- the DST-NRF Centre for Invasion Biology (C•I•B) at Stellenbosch University (www.sun.ac.za/cib). The meeting attracted 240 delegates from at least 29 countries, with topics from Antarctic to Greenland. Special sessions and workshops were organized to stimulate better communication within research and management groups on specific topics. These include pine invasions, invasions in mountain ecosystems, protected areas and invasive species, and more general themes such as risk assessment methods, experiences on the management of invasive plants, policy regulations and funding of eradication and monitoring campaigns. Seven plenary presentations from leading figures from around the world were given on topics ranging from a scientific review of the biology of alien species and invasion patterns, to management and policy topics, by Marcel Rejmánek, Mark Burgman, Spencer Barrett, Sue Milton, Peter Dye, Petr Py?ek and Arne Witt.

Plant invasions affect all aspects of human well-being, economy and biodiversity, many of which were covered at EMAPi. The wide scope of EMAPi 10 and topics covered was clearly evident in the conference programme. Most of the time there were three parallel sessions, giving in total more than 130 talks. Themes included the ecology and biology of individual species, climate change, risk analysis, mutualistic relationships, important management strategies, early detection and eradication, the role of trade and policy, and many other disciplines. The meeting strengthened the importance of perceptions of non-traditional topics such as communication, education & social marketing, policy studies, and linkages with restoration ecology or molecular ecology.

The importance of moving such an international meeting to South Africa was highlighted by the conference chair, Dave Richardson, when he mentioned Africa as a continent being clearly underrepresented in published studies on invasive species. The poor knowledge of the extent and impacts of invasions across the African continent undermines current management initiatives to reduce impacts of invasive species on biodiversity and ecosystem functioning in African ecosystems. This is underpinned by the lack of resources in many African countries where the capacity of developing countries is significantly constrained, especially with regard to addressing problems related to invasive species. Citing Richardson, we can agree that "These include factors that people in developing countries tend to take for granted, like the presence of a stable community of scientists, the availability of a corps of volunteers to participate in key phases of research and management, and a high level of public awareness of the problems associated with invasions. On the other hand, people in developing countries have a higher dependence on natural resources, and in some cases are the custodians of the most important biodiversity hotspots. But, access to cheaper labour may open doors for operations that are impossible in developed countries." Here we would like to highlight the active participation of local communities and nature conservation managers in dealing with invasive species, as they presented their activities in many of the EMAPi workshops and sessions. This conference hopefully represents a promising starting point in widening international cooperation within Africa, where seven African countries were already represented at the conference.

Last but not least is a warm invitation to all who are interested in biological invasions, from scientists, managers and policymakers, and especially those who haven't attended before, to the next EMAPi conference in Hungary in 2011. For details on the conference you can contact Dr. Zoltan Botta-Dukat (e-mail: *bdz@botanika.hu*). The organisers of EMAPI 2009 thank the sponsors who generously contribute toward the conference and its success.

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Management of invasive alien species in Andalusia (Southern Spain): some successful experiences

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The Consejería de Medio Ambiente (hereinafter CMA) is part of the Junta de Andalucía (Regional Government of Andalusia) and responsible for managing the conservation of biodiversity in the Andalusia region (Southern Spain). This territory covers an extension of 87600 km^2 and a human population of 9 million inhabitants. It houses a high number of wild species including more than 4000 species of plants and some 530 species of vertebrate fauna, and an unknown number of invertebrate species. Many of these species are threatened and/or their supporting habitats are considered of European Community Interest according to the Council Directive 92/43 on the Conservation of Natural Habitats of Wild Fauna and Flora. To slow down the loss of biodiversity in natural ecosystems due to alien invasive species, in 2004 the CMA launched the Andalusia Programme for the Control of Invasive Alien Species, with a biannual funding of 1.4 million (plus 1 million for emergency actions). The aim of this Programme is the design, development/implementation of methodologies for the management of invasive species, the analysis of viability of each management option according to its feasibility and to provide help for the coordination among stakeholders involved. An adaptive and integrated approach has been developed by CMA for population control, erradication, information for prevention of new introductions and early detection of more than 40 alien species. Each scenario and action developed was previously selected after the application of risk analysis tools, cost-environmental benefit analysis and feasibility of actions. Due to the variety of species and habitats managed, it was adopted a multidisciplinary approach involving other regional programmes for Conservation of Biodiversity in the fields of terrestrial and marine species and ecosystems. Besides, the Programme counts with the advisory role of investigation centres.

In this communication, an extract of successful experiences achieved in the period 2005-2008 is shown (see Table).

Alien species	**Strategy**	**Native and threatened species affected**	**European Habitats of Community Interest affected**	**Ecosystem response after the action**
Agave americana	Eradication	*Juniperus phoenicea* (VU); *Cynomorium coccineum* (VU)	Sea dunes of the Mediterranean coasts	Recovery of plant community
Carpobrotus spp.	Eradication	*Corema album* (VU); *Juniperus phoenicea subsp turbinata* (VU); *Juniperus macrocarpa* (EN); *Armeria pungens* (VU); *Limonium emarginatum* (VU)	Sea dunes of the Mediterranean and Atlantic coasts; *Coastal dunes with Juniperus spp; *Wooded dunes with *Pinus pinea;* Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.	Recovery of plant communities and of endangered species

Alien species	Strategy	Native and threatened species affected	European Habitats of Community Interest affected	Ecosystem response after the action
Mesembryanthemum crystallinum	Population control	*Senecio alboranicus* (CR), *Diplotaxis siettiana* (CR)	Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.	Recovery of plant community
Cyprinus carpio	Eradication	*Oxyura leucocephala* (EN), *Alytes dickhilleni* (VU)	Natural eutrophic lakes; mountain oligotrophic waterboides	Recovery of the ecosystem and endangered species
Eriocheir sinensis	Contention	Native fish species	Estuaries	Decrease of stock (near casual)
Pacifastiacus leniusculus	Contention to prevent intentional introductions into other rivers (population maintained under level of environmenta l risk)	*Austrapotamobius pallipes* (CR)	Constantly flowing Mediterranean rivers hanging curtains of *Salix* and *Populus alba*	Decrease of population
Procambarus clarkii	Local Contention (small dams)	*Austrapotamobius pallipes* (CR)	Constantly flowing Mediterranean rivers hanging curtains of *Salix* and *Populus alba*	Low risk of transmission of aphanomicosis. No red swamp crayfish present within the contention area
Trachemys scripta subsp. *elegans*	Eradication	*Mauremys leprosa*; *Emys orbicularis* (NT)	Mediterranean permanent ponds	Recovery of native sliders

These experiences show how effective management of alien species can be achieved with the necessary investment of human and economic resources, a multidisciplinary approach involving the different regional conservation programmes and the application of technical tools based in risk, viability and cost-benefit analyses. This approach also improves the management results in terms of efficient use of resources.

More information: *http://www.cma.junta-andalucia.es/medioambiente/site/web/*

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Figure 1a-b. Recovery of *Alytes dickhilleni* (VU) populations following eradication of carps and goldfish in small mountain wetlands by electric fishing.

Figure 2. Control of red-eared slider turtles (*Trachemys scripta* ssp. *scripta*) in Mediterranean wetlands using floating traps (a) and active search for nests (b-c).

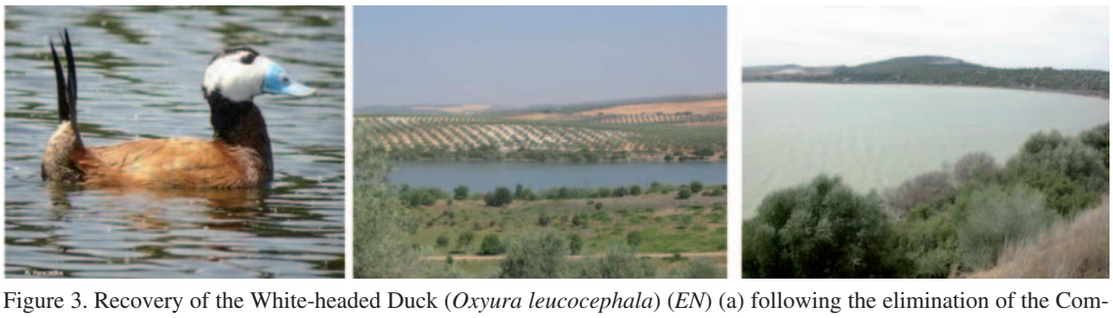

Figure 3. Recovery of the White-headed Duck (*Oxyura leucocephala*) (*EN*) (a) following the elimination of the Common carp (*Cyprinius carpio*) in freshwater wetlands of International Importance for Bird Conservation: Zóñar lake (b) and Medina lake (c).

Figure 4. Manual, selective removal of *Carpobrotus* spp. from sea cliffs of the Mediterranean coasts with endemic *Limonium emarginatum* and endangered species such as *Juniperus macrocarpa* (a). Pictures of Armeria pungens (VU) before (b) and 3 years after (c) the removal works.

Figure 5. Fyke nets used for contention of Chinese Mitten crabs in the Guadalquivir Estuary (a) and a captured mitten crab (b).

Figure 6. Management of the signal crayfish (*Pacifastacus leniusculus*) in a Mediterranean river, using a combination of methods: electrofishing (a); artificial refuges (b) and baited minnow traps (c).

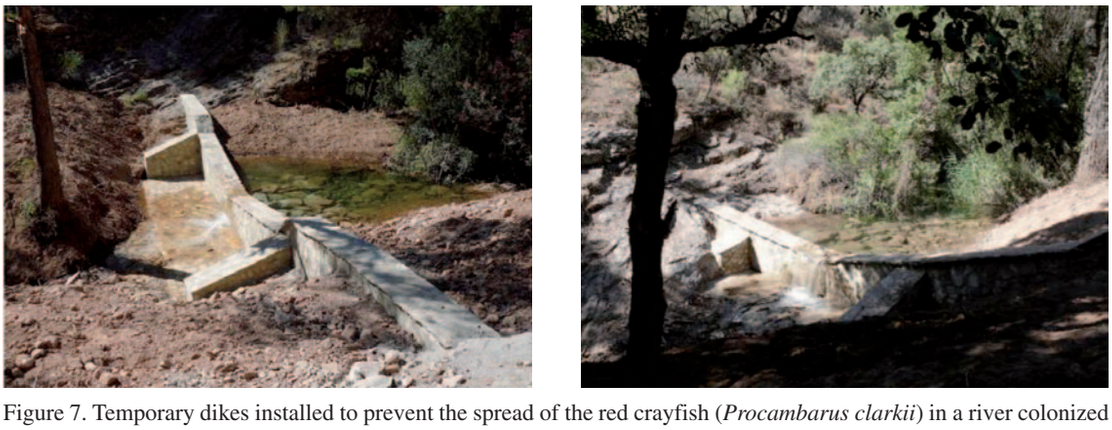

Figure 7. Temporary dikes installed to prevent the spread of the red crayfish (*Procambarus clarkii*) in a river colonized by the native and endangered white-clawed crayfish (*Austropotamobius pallipes*)

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New publications

Protect your ports against invasive species

Ports and trade hotspots in the United States should will have better ways to detect invasive species and more rapid response protocols, according to a new report from the International Union for Conservation of Nature (IUCN).

Neighborhood Watch - Early Detection and Rapid Response to Biological Invasion Along U.S. Trade Pathways, says accidental introductions of pests and pathogens threaten economic, environmental and public health.

"Countries all over the world are responsible for sending and receiving invasive species," says Geoffrey Howard, IUCN's Global Invasive Species Coordinator. "As a result, we can only hope to succeed in controlling the problem with international cooperation. The long-term hope is that countries will eventually become responsible for their exports of live organisms, but first there is need to manage the imports."

The report, a product of an agreement between IUCN and the US Environmental Protection Agency, identifies the crucial measures needed to plug the gaps in our ability to detect species that would otherwise evade inspection and quarantine measures along trade pathways. The publication urges swift action to improve biosecurity measures, including improved coordination between agencies and greater international cooperation. Projects that address some of the main recommendations in Neighborhood Watch are already being developed, including a trade and invasives learning network pilot project in the Caribbean.

For decades, the United States has relied upon methyl bromide to prevent the accidental introduction of agricultural pests. But this powerful toxic gas is being phased out because it is as an ozone-depleting substance banned under the Montreal Protocol on Substances that Deplete the Ozone Layer and the Clean Air Act.

"A serious reconsideration of our national biosecurity system is now in order," says Dr. Randy Westbrooks, an invasive species prevention specialist with the U.S. Geological Survey. "As species overcome geographical barriers, abetted by ever expanding global trade and travel, our ability to intercept potentially harmful organisms is being challenged as never before, posing serious threats to our agricultural and biological security."

Solenopsis invicta, red imported fire ant - Photo: © Dennis Kunkel Microscopy Inc

Trade regulators have not yet fully integrated biosecurity concerns into trade negotiations, and governments have failed to invest sufficiently in risk assessment and in the infrastructure and information that would make this possible, according to the report.

Neighborhood Watch offers recommendations to improve biosecurity measures at U.S. ports, as well as a possible funding mechanism based upon the "polluter pays" principle.

While focused on the case of the United States, it addresses a universal problem and recognizes that the solution requires the full participation of all trading partners.

The publication offers the following recommendations:

- Establishing interagency and intergovernmental cooperation through risk committees;
- Building upon the work already being done in the agriculture sector under the US Department of Agriculture's Animal and Plant Health Information Service, develop interagency rapid response capacity, using scenario based planning;
- Promoting international cooperation through the establishment of an "INTERPOL" for pests and invasive species;
- Establishing Learning Networks linking inspection services and port authorities to one another and to the scientific community;

- Developing and implementing a comprehensive surveillance system that builds upon the sectoral work done in agriculture and forestry to capture the full range of potentially harmful organisms.
- Developing a sustainable finance mechanism to support these measures, and
- Undertaking further study on the legal aspects of early detection and rapid response, including authority for instigating rapid responses in different jurisdictions and contexts.

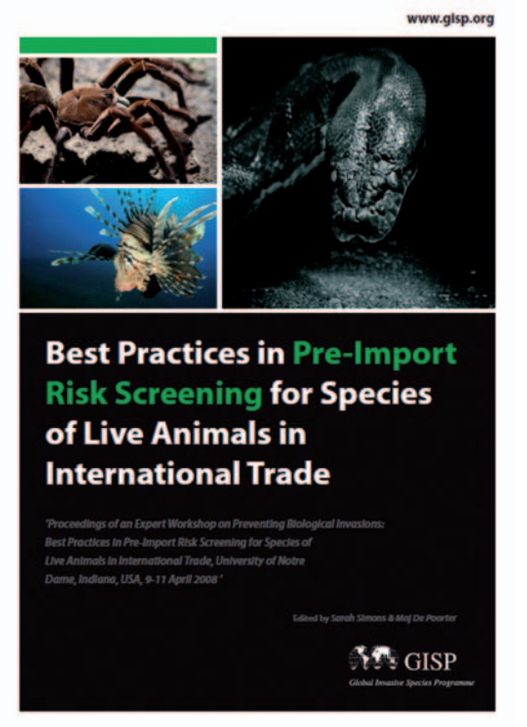
The publication carries a heavy warning: failure to adopt a more realistic biosecurity strategy will be costly, and will be paid in perpetuity.
The transition from a piecemeal approach to biosecurity to a more coordinated, vigilant one requires a highly sophisticated approach to information and knowledge management, dedicated resources, and improved technologies for port of entry inspection and clearance, the report says.
Over the past decade, several countries have made important strides in this direction, including Australia, New Zealand, and the United States. However, the world would benefit even more if leaders in biosecurity commit to developing new approaches that ensure the integrity of key control points along the international trade 'pipeline' – from commodity point of origin to final destination, according to the report.

The report is available online:
http://www.iucn.org/about/union/secretariat/offices/usa/about_usa/invasive/
For more information or to set up interviews, please contact:
Taffeta Gray, Communications Officer, m +1 202 330 3615, e *taffeta.gray@iucn.org*

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

The Rapporteur's summary report (32 pp) is now available of the proceedings of the University of Notre Dame live animal trade expert workshop, held April 2008, printed by Global Invasive Species Programme (GISP). Title: *Best Practices in Pre-Import Risk Screening for Species of Live Animals in International Trade.* On GISP website at:
http://www.gisp.org/publications/policy/workshop-riskscreening-pettrade.pdf .

The report includes valuable information on the "why" and "how" of pre-import risk screening for invasiveness and disease, with extensive information on how it is done achieved in some countries, the various challenges involved, and how it can be done achieved more broadly and bettereasily.



Biodiversity special issue

The objective of Biodiversity, the Journal of Life on Earth, is to contribute to the understanding, protection
and restoration of the diversity of living things With this in mind, the new Biodiversity special issue is a contribution to the global effort dealing with IAS. Specialists from many parts of the world have contributed valuable IAS information published in this issue that will be disseminated globally. Also, the abstracts of this special issue of Biodiversity were presented online *http://www.tc-biodiversity.org* for '"The International Day for Biological Diversity - Invasive Alien Species" 22 May 2009, organized by the
Secretariat of the Convention on Biological Diversity.

Biodiversity 10 (2+3) 2009 Special Issue on Invasive Alien Species
Issue Preview (132-page special issue) can be downloaded at the following web site:
http://www.tc-biodiversity.org/Invasive_Alien_Species_prev.pdf

Events

World Conference on Biological Invasions & Ecosystem Functioning (BIOLIEF)
27-30 October 2009, Porto, Portugal.

The BIOLIEF Conference will be devoted to the presentation of works concerning the biology, ecology and population dynamics of biological invasions.
The BIOLIEF Conference will try to cover as many ecosystems and kingdoms countries as possible, giving each one of them equal importance in the definition of the final program
For further details, you can visit the webpage *www.ciimar.up.pt/biolief/*

International Congress on Biological Invasions Managing Biological Invasions under Global Change
2- 6 November 2009, Fuzhou, China.

The Congress is planned to be a forum to deliberate on the increasing invasive alien species (IAS) issues worldwide, targeting the needs of IAS management at national, regional and international levels. The ICBI also aims to provide a platform for the exchange of research developments and tracking of technical progress in multidisciplinary topics dealing with IAS. Additionally, it will address gaps between research and field application related to biosecurity, quarantine and international trade as well as on the linkages and impact of climate change on biological invasions
For further information visit the site *www.icbi2009.org/*

Island Invasives: Eradication and Management Conference
8–12 February 2010, Auckland, New Zealand

This conference will be held at Tamaki Campus, University of Auckland, New Zealand from 8 to 12 February 2010, hosted by the Centre for Biodiversity and Biosecurity (University of Auckland & Landcare Research), in collaboration with the IUCN/SSC Invasive Species Specialist Group. The conference will continue, and expand on, the theme of the very successful conference held in 2001 – *Eradication of Island Invasives*. We have a very full programme of 96 oral presentations and more than 40 poster papers. A conference proceedings will be published. This conference is limited to 300 attendees. We already have half of these spaces booked.
For more details, and to register to attend, go to *www.cbb.org.nz/conferences.asp* This pageThe webpage is beingwill be updated as conference preparations progress.

17th Australasian Weeds Conference
26-30 September 2010, Christchurch, New Zealand

The 17th Australasian Weeds Conference is to be held in Christchurch, New Zealand from 26-30 September 2010. This will be the first time this conference is has been held in New Zealand and offers a unique opportunity to meet and share ideas with your New Zealand colleagues.

In the past this conference has only been held in Australia but the recent inclusion of the New Zealand Plant Protection Society into the Council of Australasian Weed Societies (CAWS) has allowed New Zealand to host the conference.
As in the past, this the conference brings together a stimulating mix of practitioners, researchers and

managers and covers will cover a wide range of topics. For more information on the range of topics please go to the conference web page at www.17AWC.org for a copy of the draft programme. As well as the wide range of papers that will be presented, there will also be five day -long field trips covering: environmental weeds, aquatic weeds, forestry weeds, weeds of cropping and weeds of pastures.
The conference web page is now open to receive paper abstracts and the close-off date is 31 October 2009. All papers will be published in a pre-printed proceedings but can be offered to the conference as either oral presentations or poster presentations. All instructions for authors are on the conference website.
As in the past members of any state weed society qualify for the 'members' fee category when registering for the conference.
For further information you may contact Trevor James (President, New Zealand Plant Protection Society) at trevor.james@agresearch.co.nz

Biosecurity in the new Bioeconomy: threats and opportunities
19-21 November 2009, Canberra, Australia

The symposium, Biosecurity in the new Bioeconomy: threats and opportunities, will take place in Canberra on 19 – 21 November 2009. The symposium will explore how research and policy can contribute to the development of new sustainable crops for new bioindustries that pose only easily manageable economic, social or environment threats.
The outcomes of this the symposium will have a major impact on assisting science and policy development for managing safe production systems for the new crops of the 21st century. This symposium will also explore the enormous opportunities new crops offer 21st century custom-built integrated pest management strategies to deliver sustainable profitability for these new industries.
CSIRO will host this event which brings together national and international scientists to discuss a range of topics including:
- the global bioeconomy
- benefits, environmental risks and biosecurity issues of biofuel crops
- research and development opportunities for bioindustries
- national and international agricultural biosecurity policy.

For more information please visit the following website: www.csiro.au/events/Biosecurity-Symposia.html

NEOBIOTA 2010 - Biological Invasions in a Changing World - from Science to Management
14-17 September 2010, Copenhagen, Denmark

The Faculty of Life Sciences, University of Copenhagen, is hosting the 6th European Conference on Biological Invasions NEOBIOTA. The organising committee is pleased to invite all those who are interested in invasive plants and animals, to register and submit abstracts for oral and/or poster presentations at the conference homepage http://cis.danbif.dk/neobiota2010. Here you will also find more detailed information about the conference venue, topics, accommodation, etc. Everyone interested in Biological Invasions is invited to participate and share ideas, new results and opinions.
All professions (ecologists, conservation agencies, stake-holders), all organisms (plants, animals, pathogens, fungi) and ecosystems (marine, freshwater, terrestrial) will be considered. Please, note that the conference will be limited to 300 participants, and that the deadline for registration and submission of abstracts is 15 March 2010.

International Invasive Ant Management Workshop
27-29 April 2010, Darwin, Australia

This focused workshop aims to facilitate networking among people involved in invasive ant management, as well as to improve the incorporation of research and ant biology into management. The workshop will be hosted by CSIRO, with accommodation at the Mirambeena resort within Darwin city. This workshop will be limited to 60 people due to restricted facility size. As such, priority will be given to people who are actively involved in decision making and ground work of invasive ant management, especially eradication programs. Participants will be expected to provide a brief (30 second) presentation of themselves and their work, and are also encouraged to propose a longer talk (15-20 minutes) of any aspect of invasive ant management that they deem of relevance to the workshop. All details of the workshop can be found at http://www.terc.csiro.au/iiamw/

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• The New Zealand Department of Conservation
• National Biological Information Infrastructure (NBII), USA
• Biosecurity New Zealand

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