Aliens: The Invasive Species Bulletin

Newsletter of the IUCN/SSC Invasive Species Specialist Group

Issue Number 29, 2010

ISSG Invasive Species Specialist Group

IUCN

SSC Species Survival Commission

ISPRA Institute for Environmental Protection and Research

Aliens: The Invasive Species Bulletin

Newsletter of the IUCN/SSC Invasive Species Specialist Group

ISSN 1173-5988

Issue Number 29, 2010

Coordinator
Piero Genovesi, ISSG Chair, ISPRA

Editors
Piero Genovesi and Riccardo Scalera

Front Cover Photo
Oxyura jamaicensis (Ruddy duck).
© Photo by Mark Hulme

The following people contributed to this issue
Shyama Pagad, Carola Warner

The newsletter is produced twice a year and is available in English. To be added to the mailing list, or to download the electronic version, visit:
www.issg.org/newsletter.html#Aliens

Please direct all submissions and other editorial correspondence to Riccardo Scalera
scalera.riccardo@gmail.com

Published by
ISPRA - Rome, Italy

Graphics design
Franco Iozzoli, ISPRA

Coordination
Daria Mazzella, ISPRA - Publishing Section

Administration
Olimpia Girolamo, ISPRA – Publishing Section

Distribution
Michelina Porcarelli, ISPRA – Publishing Section

Printer
CSR - Via di Pietralata, 157 - 00158 Roma
Phone 064182113 (r.a.) - Fax 064506671

CONTENTS

Editorial

An article published in Science last 30 April 2010, by Butchart and colleagues, has compiled over 30 indicators measuring different aspects of biodiversity. It, has shown that there is no evidence of any reduction in the rate of decline of biodiversity and that, on the contrary, pressures continue to increase. These results confirm, with a solid science-based assessment of the available data, that the 2010 target has not been met, and that the efforts put in place by the world leaders to preserve the diversity of life have been largely inadequate.

The Science article stated that biological invasions have increased in Europe by 76% in the last 40 years are increasing and invasive alien species - as stressed by the paper by McGeoch and co-authors published earlier this year in *Diversity and Distribution* (16, 95-108) – are indeed a major driver of biodiversity loss, that in many cases strongly affect the conservation status of threatened species.

Both of these recent articles report on some encouraging developments: 83% of the world's countries have signed international agreements to tackle invasive alien species, and 55% have adopted national legislation to control and/or limit the spread and impact of biological invasions.

There are increasing cases of successful conservation actions, as in the case of the black stilt in New Zealand, whose extinction has been prevented through a combination of predator control, habitat restoration and translocation programs. As a result of active conservation, several threatened vertebrate species have improved their conservation status sufficiently to be down-listed to a lower category of threat on the IUCN Red List.

It must be stressed that these positive outcomes are in most cases the consequence of successful eradication programs that have removed the predators affecting species of conservation concern. Eradication is in fact one of the most effective tools we have to respond to the continuing decrease in species' numbers, also, the significant advances in eradication science that have been gathered in the past decades.

The contributions presented at the international conference on "*Island Invasives; eradication and management*", held in Auckland, New Zealand in early February (see the article in this issue), clearly demonstrate these advances. The number of eradications targeting several species simultaneously has much increased in recent years; the risk of undesired effects of eradications have been minimised, and adaptive implementation of eradications has prevented, or rapidly mitigated, potential unexpected chain reactions. Furthermore, we are now able to target not only vertebrates, but also plants and terrestrial invertebrates, and to remove invasive species from large areas, even on the mainland.

But management of invasive species is not the only tool we have in our hands. The experiences gathered in several areas of the world have also shown that stringent biosecurity policies can prevent a large part of invasions, protecting not only the environment, but also economies. For example, if Australia remains free of the varroa mite – a pest that has caused the collapse of the honey industry in many countries of the world - this is likely due to the strict biosecurity policy adopted in that country. A large proportion of the economic losses to the European economy caused by invasive species could be prevented with stricter import regulations.

As Stuart Butchart said, commenting on the article published in Science (of which he was the primary author), "*2010 will not be the year that biodiversity loss was halted, but it needs to be the year in which we start taking the issue seriously and substantially increase our efforts to take care of what is left of our planet*". The efforts to tackle biological invasions will be a crucial test of a renewed global attention to the problems of the life on earth we all hope to see at the end of 2010.

Piero Genovesi, ISSG Chair

News from the ISSG

The Invasive Species of the Week
Following the brilliant idea from the IUCN Red List Species of the Day, ISSG using the same concept has launched the 'Invasive Species of the Week' to raise awareness of the impacts of invasive species on native biodiversity and threatened ecosystems.
We have created a button which can be placed on your website, which will link to a PDF file of the weekly species fact sheet. A code needs to be embedded into your site. Once this code has been added to your website, no further changes on your part are necessary; the button will link to a different invasive species each week automatically with a change in the image on the button.
The code is as follows:
<iframe src="http://www.issg.org/invasive_species_ofthe_week/is_ofthe_week.html" frameborder="0" width="185" height="205" scrolling="no"></iframe>
The feature has been adopted by several websites and has proved to be very popular.

Supporting the development of an early warning system in Europe
The ISSG and ISPRA have worked, under a contract with the European Environment Agency, at a report on "Towards an early warning and information system for invasive alien species (IAS) threatening biodiversity in Europe", that has assessed the feasibility of establishing a European early warning framework. As a follow up, it has recently been decided to publish an abridged version as an EEA Technical Report to be used as a basis for future policy developments at the regional scale, and particularly in the context of the recent European Commission (EC) communications, among which "Towards an EU Strategy on Invasive Species" (2008).
The EEA Technical Report is available online at:
http://www.eea.europa.eu/publications/information-system-invasive-alien-species/

Island Invasives: Eradication and Management Conference
Several ISSG members participated and made valuable contributions to the 'Island Invasives: Eradication and Management Conference' held at the Tamaki campus, University of Auckland, New Zealand during February 2010. Over 240 people from 25 countries participated in this conference. Dr. Piero Genovesi, Chair of ISSG gave the keynote address titled 'Are we turning the tide? Eradications in times of crisis; how the global community is responding to biological invasions'.

Volcanic eruption in Iceland slows down IAS policy progress
At its 9th meeting, the CBD Conference of the Parties requested the Executive Secretary to collaborate with relevant international organizations with a view to exchange information on the regulatory frameworks, and to seek out means to address the gaps and inconsistencies of the international regulatory framework in relation to invasive alien species. Following this decision, the CBD Executive Secretariat has established an Inter-Agency Liaison Group on Invasive Alien Species, and has invited ISSG to be part of it. The first meeting of the liaison group was planned to take place at the headquarters of the World Organisation for Animal Health (OIE) in Paris last 19-20 April, but unfortunately, because of the flight ban due to the cloud of ash from a volcanic eruption in Iceland, the meeting had to be postponed.

...And other news

Great Britain authorises the use of a weed biocontrol agent for the first time in Europe

On 9th March the UK Wildlife minister authorised the release of the psyllid *Aphalara itadori* for the control of Japanese knotweed, one of the IUCN's top 100 invasive species. This is the first time that an EU Member State has taken such a move and the project may be of interest to other Member States where this species is a problem. Japanese knotweed, *Fallopia japonica* was brought to the UK in the early 19th Century as a prized garden plant but soon moved from prize-winner to pariah after showing its ability to spread and its resistance to control. Despite its inability to spread by seed, at least in the UK, it is remarkable that it is now to be found in almost every corner of the country. Research into potential agents for a classical biological control programme was initiated in 2003 and CABI scientists, in collaboration with a Japanese team at the University of Kyushu and many others, were able to select the psyllid as the most promising of more than 180 insects that feed on the plant in Japan. Six years of host range testing, following International protocols, were carried out in quarantine in the UK and the sap-sucker was shown to be a true specialist with a clear preference for the target weed and an inability to develop on any non-target plants of concern.

Whilst the science was not always easy, the novelty of the project for Europe presented the challenge of navigating European and national legislation that was not designed with the release of biocontrol agents in mind. For release to be authorised, two legislative pathways had to be pursued: the Wildlife and Countryside Act 1981 to legalise the release into the wild of a non-native species, and the Plant Health Act to free it from the Plant Health Quarantine Licence under which it is being held. As an organism liable to be injurious to plants in the UK, it was clear that the psyllid would be best considered under European Plant Health Regulations effectively as a "beneficial pest". Thus the EPPO Pest Risk Analysis template was used to provide the information necessary for consideration by various experts, independent peer reviewers and finally a 3 month public consultation. Many people are acutely aware of the impacts of the cane toad in Australia which was often mentioned in the media as an example of biocontrol gone wrong. However, the extensive information provided has helped ensure that the general public mood in the UK is supportive of the proposal. The decision generated considerable national and international interest in the press, television and radio as well as in other fora. The project, funded by a consortium of bodies, is being delivered against a backdrop of increased awareness of invasive species issues and a reduction in the number of pest control products available, not to mention a decrease in the acceptability of the use of chemicals in the eyes of the public. The project is now set firmly within the policy framework of the "Invasive Non-native Species Framework Strategy for Great Britain" and its pursuit through the relevant regulatory regimes may set a helpful precedent for other EU countries in undertaking similar projects. The carefully controlled release process is expected to start in Spring 2010 and will be accompanied by a detailed monitoring programme.

Further reading:

http://www.defra.gov.uk/corporate/consult/japanese-knotweed/letter.htm

http://www.cabi.org/japaneseknotweedalliance

Shaw RH, Bryner S, Tanner R (2009) The life history and host range of the Japanese knotweed psyllid, *Aphalara itadori* Shinji: Potentially the first classical biological weed control agent for the European Union. Biological control 49:105-113.

Japanese knotweed (*Fallopia japonica*). Photo: Riccardo Scalera

Code of Conduct on aquatic plants in The Netherlands

After years of negotiations on February 23rd 2010 a Code of Conduct on aquatic plants has been signed at the Hortus botanicus of Leiden Univer-

sity. The document was signed in a most appropriate setting, being the tropical greenhouse adorned by luxurious palms, orchids, impressive lianas and some very ornamental tropical aquatic plants. Partners signing the Code of Conduct represent both the public and private sector, management authorities suffering from the prolific growth of invasive aquatic plants as well as those having an economic interest in the sale of these plants. Signatories are: the 'Unie van Waterschappen' on behalf of all 26 local water boards of the Netherlands, the ministry of Agriculture, Nature and Food safety as well as umbrella organisations and various associations representing both producers, importers, retailers and garden centres such as: DIBEVO, Tuinbranche Nederland, De Nederlandse Bond van Boomkwekers, De Vereniging van Vasteplantenkwekers. In addition to this several individual importers and producers of aquatic plants have signed the Code of Conduct.
As of January 1st 2011, the signatories of the Code of Conduct will refrain from selling 6 species in the Netherlands. An additional 7 species will only be on sale accompanied by recommendation concerning the appropriate use and disposal of the plants. The 6 species that will no longer be on sale as of January 1st 2011 are: *Crassula helmsii*, *Hydrilla verticillata*, *Hydrocotyle ranunculoides* (prohibited since 2010), *Ludwigia grandiflora*, *Ludwigia peploides* and *Myriophyllum aquaticum.*

Those on sale with recommendations to use them wisely as of January 1st 2011 are*: Azolla spp., Cabomba caroliniana, Egeria densa, Eichhornia crassipes,Myriophyllum heterophyllum Pistia stratiotes* and *Salvinia molesta.*

Myriophyllum aquaticum. Photo: Johan van Valkenburg

A communication campaign is part of the Code of Conduct. A leaflet for the general public informing them how to use the plants wisely will be available at garden centres and pet shops selling aquatic plants and can be downloaded from the website of the Dutch Plant Protection Service. A similar leaflet to create awareness among land managers will be launched in May 2010. A field guide to assist field staff in identification of the 20 most troublesome aquatic alien plants will accompany this leaflet. The Dutch Plant Protection Service will closely monitor the compliance with the Code of Conduct and the effect of the communication campaign.

For more details visit the website of the Dutch Plant Protection Service: *www.minlnv.nl/invasieve-waterplanten* (at present in Dutch only).

New regulation to control IAS for the Valencia region, East Spain

The government of the Valencia region (East Spain) has published a Decree by which measures to control exotic invasive species are adopted.
The objective of the new regulation is to prevent the introduction and spread of exotic plant and animal species in the Valencia region in compliance with national Law 42/2007 of natural heritage and biodiversity which entitles the different regions of Spain to establish their own catalogues of invasive species. To achieve this goal the decree establishes two lists of species to which different limitations apply.

The first list or annex I includes animal – 19 species and all exotic fresh water crabs - and plant species – 8 species, 4 genera - whose sale, transport – except that needed for eradication works - release, plantation or dispersal of specimens, their propagules or remains is banned anywhere in the Valencia territory. It is also established that exotic animal species not included in annex I will not be released except in enclosures linked to human activities if appropriate measures to avoid dispersal are adopted and no damage to native species can be derived. Possession of annex I species is not prohibited, but it is established that physical or juridical persons that keep these species when the Decree enters into force must adopt all measures to prevent their dispersal and that particular requirements for the possession of certain species will be specified.
Annex II lists only exotic plant species – 31 species, 5 genera -. Marketing of these taxa is not

banned but they will not be planted or dispersed in forest areas and wetlands or used in plantations along roads that run through non urban land. They can however be kept in gardens with well defined borders provided that they do not propagate outside their boundaries. The Decree also establishes that remains of plants included in both annexes must be disposed of at authorised dumps and that dumping in the wild will be fined.
The issue regarding the sale of goods carrying exotic species is also addressed. Should goods offered for sale be found carrying species of annex I they will be quarantined and isolated until guaranteed to be free from alien species. If the latter is not possible goods will be destroyed.
The decree also highlights the need to intervene at an early stage of the invasion. An emphasis is put on the need to detect exotic species at an early stage through the establishment of a detection network among the environmental agents (267) and the staff of the 18 natural parks of the Valencia region. Adequate training to members will be provided so that they will be able to identify species in the field. Urgent eradication, without the need to draft control plans is also considered. An important step to prevent failure of eradication campaigns has been adopted. In compliance with the forestry law the Valencia Region, the competent environmental authority is entitled to delimit areas affected by an invasive species and to declare eradication works of public interest. This means that landowners affected by the declaration of public interest must allow eradication works within their properties to proceed and the establishment of appropriate measures to prevent dispersal.
This decree is the first Spanish regulation to prohibit sale of exotic species and to establish a catalogue of alien species to which legally binding limitations apply.

An abridged English version of this Decree can be obtained upon request at *deltoro_vic@gva.es*

Identification key to marine invasive species in Nordic waters.

On the International Day for Biological Diversity 22 May 2010, NOBANIS (The North European and Baltic Network on Invasive Alien Species) will launch an Identification key to marine invasive species in Nordic waters on the portal *www.nobanis.org*

The identification key will guide persons in the administration of invasive alien species and others with an interest in marine life in identifying their marine specimens.

The invasive Pacific oyster *Crassostrea gigas*, which can form oyster reefs and outcompete related native species. Photo: Christian Christiansen.

The key will lead to illustrated fact sheets of the individual species with focus on the latest information in the invasive status and distribution.
It will cover crustaceans, crabs and lobsters, barnacles, gastropods, chironomid insect larvae, tunicates, bivalves, parasites, hydroids, polychaetes, ctenophores and some fish. The key will include comparisons between easily confused native and invasive species.
Invasive alien species are a considerable threat to biological diversity. It is therefore imperative to be able to distinguish alien species from native in order to monitor changes caused by these species in local ecosystems.
This key is the first Nordic project making updated taxonomic expertise on marine species more readily available to non-specialists.

For more information please contact the NOBANIS secretariat on +45 72542418 or *nobanis@sns.dk*

Conference on Island Invasives; eradication and management held in Auckland, NZ

Piero Genovesi, Mick Clout, Dick Veitch

240 people from 23 countries gathered in Auckland, New Zealand in February to attend the International Conference on "*Island Invasives; eradication and management"*, held at the University of Auckland's Tamaki Campus. This is the third conference on this general topic, following on from the very successful meetings of 1989 and 2001, also held in Auckland. Proceedings of the 1989 conference were published by the New Zealand Department of Conservation under the title "Ecological restoration of New Zealand Islands" (Towns et al. 1990). Proceedings of the 2001 conference were published by IUCN in the book "Turning the Tide: The Eradication of Invasive Species (Veitch C.R. and Clout M.N. eds; pdf available at *http://www.issg.org/publications.htm#turningthetide*).

The 2010 conference, was hosted by the Centre for Biodiversity and Biosecurity (a joint venture between the University of Auckland and Landcare Research) and the Invasive Species Specialist Group of IUCN. The organising committee included Mick Clout, Dave Towns, Alan Saunders, John Parkes, Alfonso Aguirre, Piero Genovesi, Dave Choquenot and Carola Warner, and the overall conference organiser was Dick Veitch. The conference was opened by Al Morrison, Director General of the New Zealand Department of Conservation, who stressed the importance of the efforts aimed at tackling the impacts of invasions, especially in the International Year of Biodiversity.

In the three days of the meeting, 96 oral presentations and 46 posters (abstracts available at *http://www.cbb.org.nz/Abstracts_book.pdf*) provided an updated review of the advances in the management of alien species, and analysed work done to date to discuss the lessons learned in this topic. The contributions covered all of the different aspects of invasive species management, from strategies to gain political and community support, to financial aspects of eradications, to advances in the techniques applicable to invasive species removal. A particular focus was given to the outcomes of eradications, with several contributions describing the effects of successful campaigns in increasing populations affected by invasives, as well as economic and social benefits resulting from invasive species management.

Compiling all of the available information on past and present eradication campaigns, a list of 1129 programs has been established. Of these, the large majority (86%) are reported as successful, and many eradications have been followed by improvement in the conservation status of highly threatened species. It is crucially important to circulate information on eradication campaigns in order to share technical improvements in removal campaigns, and to better communicate the power of this conservation tool, At the conference it was agreed to continue populating the database on island eradications implemented by Island Conservation (see http://db.islandconservation.org/), and to explore possibilities, in cooperation with ISSG, to continue updating this database in the longer term.

The results of this conference confirm that defending global biological diversity from invasive species is not an unrealistic target. If the world leaders want to fulfil their commitment to reverse the present rate of biodiversity loss, they should take into account the scientific advances of the last decades, and turn their formal statements into concrete action: funding and encouraging eradications of invasive species on the world's islands, to help in reducing the ongoing decrease of global biodiversity.

The peer-reviewed proceedings will be published in about a year in an IUCN book, to be edited by Dick Veitch and Mick Clout. Check the ISSG website (*www.issg.org*) for updates.

Corresponding author: Piero Genovesi

Chair IUCN SSC Invasive Species Specialist Group
www.issg.org

ISPRA (Institute for Environmental Protection and Research) Via Curtatone 3 I-00185 - Rome, Italy

‘Helping Islands Adapt’ Workshop

Shyama Pagad

The Helping Islands Adapt workshop was held in Auckland, New Zealand between the 12th and 16th April 2010. This targeted workshop was hosted by the New Zealand government together with the Department of Conservation, the New Zealand Ministry of Foreign Affairs and Trade, and Biosecurity New Zealand; and co-sponsored by a host of partners including the governments of Australia (Department of Water, Heritage and the Arts), France, Germany, Italy, Spain and UK, global organizations including the Convention on Biological Diversity (CBD), The Nature Conservancy (TNC), the Global Islands Partnership (GLISPA), the International Union for Conservation of Nature (IUCN), the Global Invasive Species Programme (GISP); and the Pacific Invasives Initiative (PII), and Landcare Research, New Zealand.

The purpose of this workshop on regional action to combat invasive species on islands to preserve biodiversity and adapt to climate change, was to ‘identify and strengthen mechanisms that enable effective and sustainable invasive species management for islands’.

Seventy five participants from 18 countries and territories and 26 national, regional and international organizations attended the workshop that focused on four major island regions –the Caribbean, the Coral Triangle, the Indian Ocean and the Pacific.

The workshop outcomes focused on four areas **a)** sharing lessons learned and identifying common factors that have resulted in successful regional coordination in the management of the spread of invasive species and climate change adaptation to the threats of invasive species; **b)** an action plan to strengthen invasive species management in the regions; **c)** establishing networks and identifying resources to achieve these outcomes; and **d)** participants identifying steps required to catalyze support within international processes to support regional action and implement recommendations of the workshop. For example at the 10th Conference of the Parties to the Convention on Biological Diversity (CBD COP10) being held in Nagoya, Japan in October 2010.

The workshop which was spread over five days was chaired by Dr. Spencer Thomas of Grenada, Chairman of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and a member of the steering committee of the Global Island Partnership (GLISPA).

Regional presentations from Mexico and the Pacific shared experiences and lessons learned. There were two technical presentations from Italy and Japan; on ‘The Italian perspective on Invasive Species Management’ and ‘The Japanese experience of Island Management’.

The World Cafe methodology was adopted with Open Space technology; participants held in-depth discussions and shared experiences and lessons learned in their work in the management of the invasive species in their regions.

Group discussion. Photo: Bill Nagle

Common themes that emerged from conversations and discussions between regional groups were:

- Recognition that the threat of invasive species is a top priority issue on islands
- Recognition that the problem of invasive species is a multi-sectoral issue and needs to be addressed across all sectors- agriculture, biodiversity, fisheries, forestry, health, trade and tourism.

- Prioritising the issue of invasive species in national legislation and regional frameworks so as to create an environment that supports management action
- Collaboration within the region and globally is valuable in capacity building and implementation of actions
- The need to improve messaging and communication and
- The need for champions

Six actions were identified for immediate attention:

- Increase coordination and integrated action within and across regions
- Increase sustained funding and the capacity to carry out management action
- Engage public and private leadership to champion the invasive species issue
- Effective communication and exchange of experiences and lessons learned within and across regions and globally; and
- Building public support for effective action

Some of the mechanisms and supporting structures identified by participants to implement these actions include:

- Taking advantage of upcoming regional and global meetings by briefing delegates attending relevant international on workshop outcomes in order to highlight the importance of invasive alien species management in relation to both islands and climate change
- Establishing and strengthening information exchange mechanisms to share experiences and lessons learned across regions, governments and communities
- Identify and engage key champions; engage civil society organizations, national, regional and global organizations

Delegates on field trip. Photo: Bill Nagle

The priorities and needs identified by the different regional groups included building baseline information (Indian Ocean); developing a regional repository to build on existing information (Caribbean); develop case studies on the impacts and costs of invasive species threats (Coral Triangle) and biosecurity and assessments of risks of spread (Pacific). Workshop documents available at *http://www.issg.org/workshop_docs.htm*

Shyama Pagad
Manager, Information Services
IUCN SSC Invasive Species Specialist Group
Regional Office for the Pacific (New Zealand)
Centre for Biosecurity and Biodiversity
University of Auckland

American beaver eradication in the southern tip of South America: main challenges of an ambitious project

Menvielle M. F., Funes M., Malmierca L., Ramadori D., Saavedra B., Schiavini A. & Soto Volkart N.

*Eradication may be considered an increasingly powerful tool to obtain significant and durable conservation outcomes. This strategy has been rarely implemented in Chile and Argentina but recently the governments of both countries signed an Agreement for the "Restoration of southern ecosystems affected by the invasion of North American beaver (*Castor canadensis*)" (2008) under which they commit to develop a project for the eradication of beavers throughout its entire range in Patagonia and Tierra del Fuego. Over 20,000 km of waterways in an area of 7.000.000 ha in the Fueguian Archipielago are already invaded by this ecosystem engineer and all types of ecosystems are affected. Beavers managed to cross the Strait of Magellan and are starting to invade the continent becoming a continental threat. The new vision for the "Beavers Project" is to recover the important ecosystem of austral Patagonia and its ability to provide environmental and economic services for the local and international community. Beaver eradication is a first and necessary step to move towards that vision. A Feasibility Study concluded that eradicating beavers from their entire distribution in Patagonia and Tierra del Fuego is feasible but difficult and a draft of a Strategic Plan for the Beaver Eradication Project has been prepared. The change of vision from 'control' to `eradication´ opened a new context of thinking and planning of conservation and alien species management in Argentina and Chile. Administrative, political, social, and economic challenges derive from this vision. Effective and efficient management of projects, science development in association with management needs, private management incorporating public and common wealth goals, insertion of international cooperation in management, will be needed. Beaver eradication from southern South America is an extremely ambitious goal but it is also the reflection of the international needs and interests in promoting and hopefully supporting this type of contribution to biodiversity conservation.*

Introduction

The historical process of eradication actions, as reflected in the publications of the Conference "Turning the Tide: The Eradication of Invasive Species" (2002) and later publications (Cromarty et al. 2003, Campbell and Donlan 2005, Parkes and Panetta 2009), has shown that eradication may be considered an increasingly powerful tool to obtain significant and durable conservation outcomes. There is a growing confidence in the ability to develop bigger, more complex eradication projects, including a wider range of ecosystems, broadening ecological goals and engaging multiple stakeholders (Saunders 2010). In the last International Conference "Island Invasives: Eradication and Management" (Auckland, February 2010), eradication was highlighted as one of the few examples of effective action against biodiversity loss, but also that there is a need for taking eradication to another level, prioritizing and supporting innovative and ambitious projects which would produce a strong momentum, encouraging the application of this conservation practice (Genovesi 2010, Saunders et al. 2010).

Eradication has sometimes been initiated in Chile and Argentina. One example is rabbits, that have been eradicated from the small island Santa Clara (221 ha), in Juan Fernandez archipelago, in Chile, a global hotspot of plant endemism which suffers severe impacts of invasive species (Bourne et al. 1992). So far, the approach chosen to solve the derived global biodiversity loss has been the implementation of a relatively continued action aimed at "control of invasive species". In this regard, the governments of Argentina and Chile are developing a novel vision for managing invasive species, approach reflected with the recent Agreement for the "Restoration of southern ecosystems affected by the

invasion of North American beaver (*Castor canadensis*)" (2008), under the Treaty on Environment (1992) and the specific Shared Wildlife Protocol. Under this agreement both countries commit themselves to develop a project for eradication of North American beaver throughout its entire range in Patagonia and Tierra del Fuego.

Figure 2. Southern tip of South America: beaver invasion region in Chile and Argentina

Figure 3. Beaver lodge and dam on a waterway in Isla Grande de Tierra del Fuego. Photo: Agricultural and Livestock Service (SAG), Chile

Why this project?

Chile and Argentina share an extremely valuable natural heritage in high latitudes of southern Patagonia and Tierra del Fuego which harbours some of the last of the wild ecosystems that exist in the Southern Cone, with relatively low levels of human impact (Figure 1). Outstanding examples of these ecosystems are the extended, continuous and primary Sub-Antarctic beach forests of Tierra del Fuego and the extended and unique peat bogs in the same region, which have a local and global significance for biodiversity conservation. Argentina and Chile also share the cultural heritage of that region, developed in a landscape marked by isolation, remoteness, harshness. Regardless of its remoteness, these distinctive environments are affected by global threats like the invasion of alien species among which the American beaver (*Castor canadensis*) is one of the most prominent.

Beavers were brought from Canada and introduced near Fagnano Lake, Tierra del Fuego, in 1946 by the Argentinean Navy to establish a fur industry. Since then, their expansion covered around 7,000,000 ha (Lizarralde 1993 in Parkes et al. 2008) including several islands like Isla Grande (4,810,000 ha), Navarino (252,800 ha), Dawson (200,000 ha), Nueva (12,000 ha), Lenox (17,000 ha), and Picton (10,500 ha). In addition, part of the Hoste island (480,000 ha), and many other smaller islands south of the Strait of Magellan have been invaded by beavers (Parkes et al. 2008) (Figure 2). This semi-aquatic rodent lives in so called colonies (i.e., family groups) mainly occupying lodges along waterways where they build dams (Figure 3). They could also live in dens along river banks or lodges built along the shores of larger rivers, and even in lakes where they do not build dams (Parkes et al 2008). According to estimates, over 20,000 km of waterways are already invaded by the species and the vigorous expansion of the beaver population can be seen in Tierra del Fuego Island, where beaver's occupancy is evidenced in almost 100% of the watersheds. The current population was estimated at 65,000 individuals, assuming an average frequency of active colonies over the entire range of 0.5/km (Parkes et al. 2008). Beavers occupy all types of ecosystems, ranging from Andean prairies and forests to Patagonian steppes, being found from sea level up to about 650 m a.s.l. (Parkes et al. 2008). So far, the only barrier to invasion seems to be the large permanent snowed areas, as for example the ice fields that mantle Andean cordillera in Isla Grande de Tierra del Fuego (Parkes et al. 2008). However, beavers managed to cross the Strait of Magellan to reach the Brunswick Peninsula in mainland Chile, which has continued for sixteen years now (Soto Volkart 2006). Evidence shows that beaver invasion is currently a problem at a near "continental" or at least "sub-continental" scale.

In Patagonia, the impacts of beavers greatly affect the functioning and structure of the ecosystems invaded. Beavers directly harm forest and other types of vegetation by consuming trees and other plants, but the most serious impacts are those derived by the damming of rivers and streams. Dam construction changes the hydrology of the entire watershed, transforming lentic ecosystems to lotic ones. As a result of beaver behaviour, *Nothophagus* forests along the riparian areas in Tierra del Fuego have been killed and replaced by beaver ponds and associated grassland-sedge dominated meadows (Lizarralde et al.2004, Anderson et al. 2006, Martinez Pastur et al. 2006, Parkes et al. 2008) (Figure 4).

There is also evidence that these beaver meadows are prone to invasions by introduced weeds (Anderson et al. 2005 in Parkes et al. 2008). Chemical composition of once pristine waters, change dramatically after beaver impact (Lizarralde et al. 1996). Beaver effects on riverine environments in steppes and peat bogs are unknown, but changes in hydrology, erosion, and sediment accumulation could be significant. In summary, a beaver certainly have a significant impact on Southern Patagonia ecosystems and biological communities, primarily as a consequence of engineering but also, as Simberloff (2009) concludes, due to other effects derived from the invasive meltdown with other introduced species, thus threatening ecosystem's functioning and persistence in the long term.

Figure 4. Beaver effects in Tierra del Fuego riverine environments: abandoned site where beech forest was replaced by a grassland meadow currently grazed by feral horses (*Equus caballus*). Photo: M. Fernanda Menvielle

Invasions also have economic effects, and beaver invasion is not an exception. Beaver flooding is affecting road infrastructure in Patagonia, as well as ranching infrastructure (Parkes et al.2008). However, economic impacts are yet to be seen in South America given the fact that *Nothofagus* forests extend northward to about 34 ºS in South America (Veblen et al. 1996 in Parkes et al. 2008), meaning that beavers have the potential to expand their range about 2,000 km to the north, going deep in the South American continent. The results of beaver engineering in mainland would significantly increase economic impacts derived from its invasion, affecting forestry and agricultural industry, reducing quality of protected areas, altering the hydrology of catchment areas that are the source for water and power supply (Parkes et al. 2008). Based on the impacts that beavers have in Tierra del Fuego, we can expect that their expansion in the continent will take not only a qualitatively, but also a quantitatively different dimension, never seen before in South America.

Beaver management in Patagonia

Beaver management in the region has had similar characteristics in Argentina and Chile. It began thirty-five years after beaver introduction in 1981, when hunting was allowed for damage control in Argentina (Parkes et al. 2008). Between 1999 and 2001 both countries started control programs encouraging commercial use as a management tool. The assumption behind these programs was that beaver pelts had a commercial value, based on which, private and public trappers were encouraged by bounties given by governments that also assisted in developing markets, to pursue beaver capture (Parkes et al

2008). "However, neither campaign was effective in controlling beavers or in stopping their spread" (Parkes et al. 2008). Similarly, governmental environmental agencies of both countries, aware of the seriousness of the problem, followed the issue in national and bi-national forums in order to install the problem as a priority.

Figure 5: Beaver trapped in Brunswick Peninsula. Photo: SAG (Agricultural and Livestock Service Chile)

After 20 years some conclusions arose in the Chilean and Argentinean management experience, including: 1) in the light of international eradication experience, commercial use alone can not solve the invasion problem; 2) beaver ecology (i.e. conspicuous presence derived from dam construction, distribution restricted to riverine environments, relatively slow population growth rate) makes beaver removal something achievable; and 3) beaver invasion represents a continental threat for the South American continent. All these conclusions led to a drastic strategy change which included the development of a new management model for this invasive species. From here, representatives of all national and regional environmental agencies of Chile and Argentina, along with NGO's, started walking a non-travelled path in order to develop a bi-national strategy for the eradication of beavers in their entire range of distribution (Rio Gallegos, August 2006). By that time, a first bi-national committee was created to implement a first agreement for beaver eradication that was further established as the formal bi-national Agreement mentioned above. This was also the result of actions implemented by the environmental agencies of both countries in order to promote the idea of eradication as a priority in both National and Bi-national fora, with the ultimate goal of giving a final solution to an old problem. This constitutes a real and significant innovation, considering the complexity and size of the beaver problem that would induce a "sort of fatalism", as Simberloff says (2002).

Shift in strategy, a new vision and a Feasibility Study

The new vision built to guide beaver management is to recover ecosystems of the southern end of South America, with two associated objectives:

1. To eradicate beavers from its current range of distribution in the southern end of South America.
2. To recover and/or restore the environments affected by beaver.

In addition to boosting the recovery of important ecosystems and the ability to provide environmental and economic services for the local and international community, the beaver eradication project expects to develop a new model for handling complex environmental problems. This new model should be based in bi-national, public/private integration, incorporation of international expertise, and in the development of scientific, technical, administrative, and institutional capacities applied for dealing with regional conservation problems.

The first step implemented under this new vision was the development of a Feasibility Study for beaver eradication, which congregated authoritative and independent expertise in eradication (2007-2008). This study, approved by both countries, summarizes beaver ecology, beavers ecological and economic impacts, beaver management, control techniques, social and political context, and discuss pros and cons of alternative management options (Parkes et al. 2008).

The beaver Feasibility Study concluded that eradicating beavers from their entire distribution in Patagonia and Tierra del Fuego is justified and feasible. Moreover, it indicated that technical, ecological, cultural, and social standpoints are available to ensure complete removal at all management units, all legal tools provided. This study also indicated that an effective and efficient bi-national management structure is required to commit cooperation of funding agencies. The study also pointed out main risks of failure, like the ability to access beavers on lands of all tenures, or the possibility of scaling eradication from the colony to the landscape level, must be resolved before any eradication is attempted. Other risks, such as the ability to manage reinvasions, will have to be tested as operations proceed (Parkes et al. 2008). The Feasibility Study also in-

dicated beaver eradication on mainland is of high priority and of urgent need to prevent further spread in the continent. To achieve this, the Feasibility Study indicates that Argentina and Chile should start by installing successful pilot eradication projects in areas similar to mainland (i.e. Andean range in Tierra del Fuego), where, with the establishment of buffers and other specific tools, management can secure for a wider eradication strategy in the continent (Parkes et al. 2008).

The Feasibility Study divided the beaver eradication project in phases, like any complex project, and estimated a period of five years from a formal start to complete active eradication (Parkes et al. 2008). Previous phases should be accomplished, including a planning and training phase, before moving into actual eradication. Finally, surveillance and reaction phases should be developed before the end of the eradication operation to assess effectiveness of the whole operation (Parkes et al. 2008). Parkes et al. 2008 made a rough estimation of the costs of implementation and surveillance of the project in the main eradication period, in ca. US$ 30-40 million, not including the initial phases or the surveillance stage following the active-eradication period.

Moving Forward with the Plan

A draft of a Strategic Plan for the beaver eradication Project was developed by a bi-national and multi agency team designed by Chile and Argentina with the support of New Zealand experts (May 2009). In the meanwhile, another team advanced in the revision of an Action Plan for beaver management in the continent, as was prioritized by the Feasibility Study. The Beaver Eradication Project should be built strategically and it is expected that the Strategic Plan becomes the master document that will guide the entire Project, highlighting the actions needed to set up the Project, emphasizing governance needs to secure national and international cooperation and funding.

The Beaver Eradication Project in Patagonia has no precedent in Argentina and Chile, nor worldwide. It is a complex project for several reasons, including: large spatial scale, several years of work, logistic difficulties inherent to the harsh Patagonian landscapes, participation of two countries, multiple jurisdictions and institutions. In addition to political challenges, the Project has social and cultural implications relating to the territory in which it will be carried out. All these complexities should be addressed systematically and explicitly, and therefore a strategic planning is essential. A document like this should be mutually agreed, should describe the overall project and provide fundamental details of the project such as anticipated outcomes, project duration, risks and costs. This Strategic Plan could allow politicians, management, or funding agencies as well as other key stakeholders to determine the nature and extent of their support to beaver eradication.

The Strategic Plan first Draft is now being reviewed, to include inputs from all key stakeholders. This Plan expects to be adaptive and it is expected to provide a basis for progress to be evaluated and for new directions and priorities to be set. Five phases were identified including: development, capacity building, eradication and restoration, and surveillance operations, biosecurity and closing. For each phase the Plan lists associated objectives and time for their completion, highlighting decision making needs. This Strategic Plan's Draft emphasizes that the Phases of Establishment and Capacity Building are crucial, and that their appropriate implementation will determine progress toward further stages of the Project.

Lessons learnt in the "beaver process"

The key lesson of this process was the relevance of the change of vision from 'control' to `eradication´. This change opened a new context of thinking and planning of conservation and alien species management in Argentina and Chile. Administrative, political, social, and economic challenges derive from this new vision, including a change of mind that can be applied and operate at the different levels related to beaver management. Effective and efficient management of projects, science development in association with management needs, private management incorporating public and common wealth goals, insertion of international cooperation in management, will be needed.

Beaver eradication from southern South America is an extremely ambitious goal. Nevertheless, ambitious as it is, it is also the reflection of the international needs and interests in promoting and (hopefully) supporting this type of contributions to biodiversity conservation. In this context, beaver eradication in Patagonia could become a flagship project for conservation worldwide (Piero Genovesi 2010).

The Beaver Project is huge, and requires effective planning, wisely selected and meaningful pilot/demonstrative experiences where good monitoring and effective and efficient reporting system are implemented. Capacity must be built at an administrative, scientific, and technical level. Political and institutional commitment to eradication will also be a prerequisite for success. Nevertheless, it

could be feasible and, moreover, it could become a unique opportunity for South America to improve conservation practice, helping in addressing other environmental problems along the Southern Cone.

Figure 6. Beavers in Tierra del Fuego National Park, Argentina. Photo: Laura Malmierca, National Parks Administration, Argentina

References

Anderson CB, Griffith CR, Rosemond AD, Rozzi R, Dollenz O (2006) The effects of invasive North American beavers on riparian plant communities in Cape Horn, Chile. Do exotic beavers engineer differently in sub-Antarctic ecosystems? Biol Conserv 128:467–474

Bourne WRP, Brooke M de L, Clark GS, Stone T (1992) Wildlife conservation problems in the Juan Fernández Archipielago, Chile. Oryx 26:43-51

Campbell K, Donlan J (2005) Feral goat eradication on Islands. Conservation biology 19:1362-1374

Genovesi P (2010) Are we turning the tide? Eradications in times of crisis; how the global community is responding to biological invasions. Keynote Speech: Island Invasives: Eradication and Management. University of Auckland, New Zealand, Invasive Species Specialist Group of the World Conservation Union (IUCN)

Lizarralde M, Deferrari G, Escobar J, Alvarez S (1996) Nutrient dynamic alterations induced by beaver (*Castor canadensis*) in the southern beech forest (*Nothofagus*). Ecología Austral 6:101-105

Martínez Pastur G; Lencinas MV, Escobar J, Quiroga P, Malmierca L, Lizarralde M (2006) Understorey succession in Nothofagus forests in Tierra del Fuego (Argentina) affected by *Castor canadensis*. Applied Vegetation Science 9:143-154

Parkes J, Paulson J, Donlan J, Campbell K (2008) Control of North American beavers in Tierra del Fuego: feasibility of eradication and alternative management options. Landcare Research Contract Report LC0708. Available in Spanish at: *www.tierradelfuego.gov.ar/s_desuamb/docs/erradica_castor.pdf* and *www.karukinkanatural.cl*

Parkes J, Panetta D (2009) Eradication of invasive species: progress and emerging issues in the 21st century. In: Clout M N and Williams PA (eds) Invasive Species Management. A Handbook of Principles and Techniques, Oxford University Press, pp.47-60

Saunders A, Parkes J, Aguirre-Muñoz A, Morrison SA (2010) Increasing the pace, scale, and effectiveness of island restoration. Island Invasives: Eradication and Management. University of Auckland, New Zealand, Invasive Species Specialist Group of the World Conservation Union (IUCN)

Simberloff D (2002) Today Tiritiri Matangi, tomorrow the world! Are we aiming too low in invasives control?. In: Veitch CR, Clout MN (eds) Turning the Tide: The Eradication of Invasive Species. Auckland, New Zealand Invasive Species Specialist Group of the World Conservation Union (IUCN)

Simberloff D (2009) Rats are not the only introduced rodents producing ecosystem impacts on islands. Biol Invasions 11:1735-1742

Towns D, Broome K (2003) From small Maria to massive Campbell: forty years rat eradications from New Zealand islands. New Zealand Journal of Zoology 30:377-398

Menvielle M.F[1], Funes M[2], Malmierca L[3], Ramadori D[4], Saavedra B[5], Schiavini A[6], Soto Volkart N[7]

[1, 3] National Parks Administration, Argentina; [2, 5] Wildlife Conservation Society, Chile; [4] National Fauna Direction, Argentina, [6] National Scientific and Technical Research Council (CONICET), Argentina, [7] Agricultural and Livestock Service (SAG), Chile.

The Eradication of Ruddy Ducks in the United Kingdom

Iain Henderson

The non-native Ruddy Duck Oxyura jamaicensis *became established in the wild in the United Kingdom in the 1960s following escapes and releases from waterfowl collections. During the 1970s and 1980s it spread into many areas of the UK and was seen with increasing frequency in mainland Europe. Hybridisation with the native White-headed Duck* O. leucocephala *was first recorded in Spain in 1991. Although the White-headed Duck is classed as "endangered", the population in Spain is heavily protected from hunting and habitat loss, so hybridisation with the Ruddy Duck is now regarded as the greatest threat to its long-term survival. Following several years of research, a programme aiming to eradicate Ruddy Ducks from the UK began in 2005. Since then over 6,800 Ruddy Ducks have been culled across England, Scotland and Wales, and data suggest that by March 2010 the UK population had been reduced by over 95%.*

Introduction

The White-headed Duck *Oxyura leucocephala* is listed as Endangered on the IUCN Red List of Threatened Animals (Hughes *et al*. 2006; IUCN 2009). This species was formerly found throughout southern Europe, parts of North Africa and much of Central Asia but its breeding areas are now highly fragmented, principally due to habitat loss and overhunting. The European breeding population is now restricted to Spain (see Figure 1 and 2), which is the only region where the White-headed Duck has expanded its breeding range and population size in recent years (Hughes *et al*. 2006). The Spanish population had fallen to as few as 22 birds at just one location by 1977 (Torres 2003), but recovered following a hunting ban which came into force in 1980. Habitat protection has safeguarded the key breeding and wintering sites for the species (Carlos Gutiérrez pers. comm.) and in recent years the post-breeding population has stabilised at between 2,100 and 2,600 birds. In 2007 breeding occurred on 32 sites in southern and eastern Spain (Carlos Gutiérrez pers. comm.).

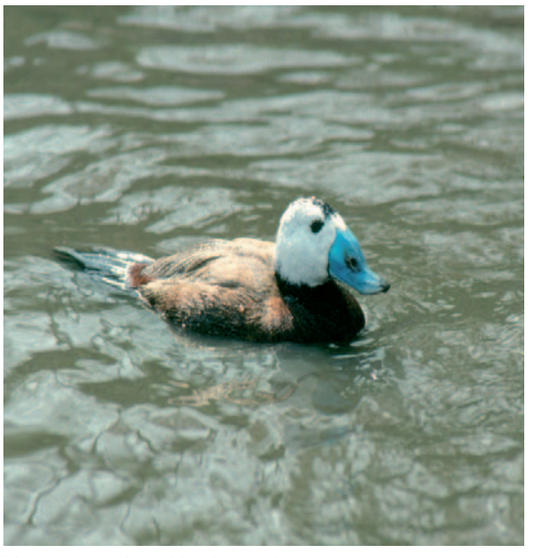


Figure 1. Male White-headed Duck.
Photo: Joe Blossom

Figure 2. Main breeding and wintering sites for White-headed Ducks in Spain

Figure 3. NARD Male Photo: Mark Hulme

The Ruddy Duck *Oxyura jamaicensis* (Fig. 3) is a native of the Americas, where it has a stable population of around 500,000 (Wetlands International 2006), but the species is an invasive non-native in the UK and elsewhere in Europe. In 1948 four males and three females were imported into a wildfowl collection in the UK but by 1961 a number had escaped or been released, and they had started breeding in the wild. During the 1960s and early 1970s the breeding range spread only slowly (Hudson, 1976). However, in the mid 1970s the UK population began to grow much more rapidly, and its range began to expand significantly. In 1983 the first feral Ruddy Duck was recorded in Spain, raising concerns about the risk of hybridisation with the White-headed Duck.

The risk to the White-headed Duck

The two species belong to the same stifftail genus but have been geographically isolated without any gene flow between them for between two and five million years (McCracken *et al.* 2000). Ruddy Ducks have been recorded annually in Spain since 1991, and the first Ruddy Duck x White-headed Duck hybrids were observed in the same year (Hughes *et al*. 1999). A total of 68 hybrids have been recorded in Spain (Mario Saénz de Buruaga pers. comm.), although the number has fallen in recent years as a control programme for Ruddy Ducks has become more efficient and fewer have been arriving. At least 184 Ruddy Ducks have been recorded (Fig. 4), in 19 provinces, since 1991 (Carlos Gutiérrez and Mario Saenz de Buruaga pers. comms.). It is known that Ruddy Duck x White-headed Duck hybrids are fertile to the second generation in captivity, which poses an increased threat to the survival of the White-headed Duck. However almost all of these Ruddy Ducks have been culled (as are hybrids) in order to prevent introgressive hybridisation.

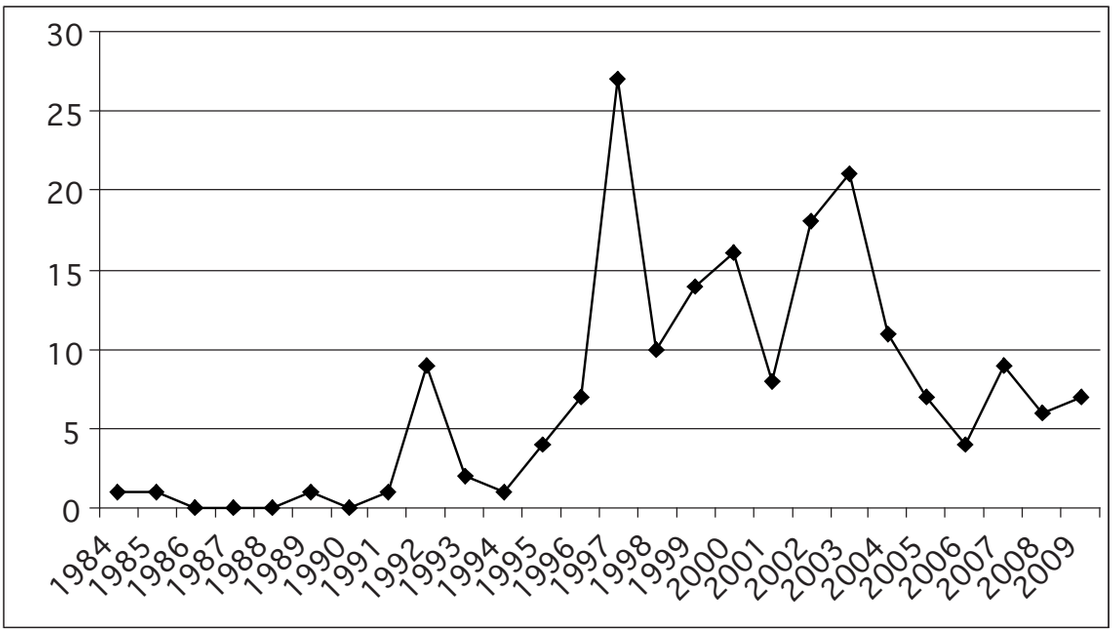


Figure 4. Numbers of Ruddy Ducks recorded in Spain, 1984-2009

The arrival of Ruddy Ducks in Europe

As the UK population grew and its breeding range spread, increasing numbers of Ruddy Ducks began to appear in Europe, most notably in the countries adjoining the UK such as France, Belgium and the Netherlands. DNA analysis has confirmed that the European Ruddy Duck population is likely to derive solely from the captive population in the UK (Muñoz-Fuentes *et al*. 2006). Captive birds are also present in some European countries, but the close correlation between the rise in the UK population and the increase in records in mainland Europe suggests that escapes from captivity are not the main source of birds in Europe. In addition, the appearance of winter flocks of 30–40 birds in France (winter 1995/96) and Spain (January 1997, following freezing conditions across northern Europe) cannot be explained by escapes from captivity (Hughes 1996). By 1999 the breeding range of Ruddy Ducks in the UK included most suitable habitat in England and Wales as well as several areas of Scotland and parts of Ireland. By January 2000, the UK population was estimated at c. 6,000 birds (Kershaw & Hughes 2002). Annual breeding attempts were also believed to occur in at least six countries in the Western Palearctic, in addition to the UK: France, the Netherlands, Belgium, Ireland, Iceland and Morocco (Hughes 1999).

The background to the eradication programme in the UK

By the early 1990s, when the UK held around 95% of all the Ruddy Ducks in Europe, it had become clear that to do nothing would eventually allow Ruddy Ducks to spread through the continent. The Spanish authorities would then find it increasingly difficult to prevent the establishment of Ruddy Ducks with the attendant risk of increasing levels of hybridisation between Ruddy Ducks and White-headed Ducks. Given that White-headed Ducks in Spain are now protected from hunting and habitat loss, it is generally recognised that introgressive hybridisation with the Ruddy Duck is now the greatest long-term threat to the White-headed Duck (e.g. Hughes *et al.* 2006).

The case of the Ruddy Duck is unique in that action has been taken in one country to protect a species in another. Ruddy Ducks were regarded by many as an attractive and harmless addition to the British avifauna, and to a lesser degree this remains the case. Many in the UK took the view that if the Ruddy Duck was a problem it should be dealt with in Spain. It was also highly uncertain whether control of Ruddy Ducks in the UK was feasible (particularly to the point of eradication), how much eradication might cost, and whether it would be acceptable to the general public. For these reasons the UK Government commissioned small-scale research into control in the early 1990s. This involved the culling of fewer than 100 birds per year and had no significant effect on the population, but the results indicated that breeding-season shooting was the most effective method of control, followed by winter shooting. Although nest trapping had a high intrinsic efficiency, the rate of control in terms of staff effort was very low and the method would therefore be an ineffective means of attempting eradication. The report concluded that eradication was feasible

but that control at a larger scale was required to better define the timescale and costs involved. This larger scale research was carried out in the form of regional control trials between 1999 and 2002 by CSL (the Central Science Laboratory (CSL), now the Food and Environment Research Agency). Further research by CSL was carried out nationally between 2003 and 2005 in order to refine the effectiveness of winter shooting. This confirmed that eradication was feasible and identified the shooting of large winter flocks from boats as the most effective way to reduce the population rapidly. Typically, between 700 and 900 Ruddy Ducks were culled each year during this period (1999–2005), leading to an apparent slight decline in the national population (Figure 6).

Significant opposition to Ruddy Duck control was limited to certain animal rights groups, although there was also opposition from many birdwatchers and some nature reserve staff, particularly volunteers. However this opposition was counterbalanced by support from the country's major conservation bodies. The support of the UK's leading conservation charity, the Royal Society for the Protection of Birds (RSPB) has been particularly crucial in helping to convince site owners, managers and many birdwatchers that the eradication programme is the only effective way to eliminate the risk posed by the Ruddy Duck to the survival of the White-headed Duck.

The eradication programme

It has long been recognised that complete eradication of Ruddy Ducks from Europe is the only effective way to remove the threat to the White-headed Duck (e.g. Green & Hughes 1996, Morley 2003) and in 2005 the Food and Environment Research Agency (FERA, an Executive Agency of the UK Department for Environment, Food and Rural Affairs, Defra) successfully applied to the European Union LIFE-Nature programme for around 50% of the cost of a £3.3M ($US4.95M) eradication programme. The other 50% was provided by Defra and a small contribution was received from the Spanish Ministry of the Environment. The aim of this programme has been the complete eradication of Ruddy Ducks in the UK. However at the outset it was recognised that this might not be achievable within the five year timescale of the programme (2005 to 2010) and FERA agreed to model the time and costs likely to be associated with the removal of any Ruddy Ducks which may remain at the end of the LIFE-Nature project. Given the small size of the original founder population, it is imperative that complete eradication is achieved and the importance of this is fully recognized by Defra and FERA, even if it involves an extension of the current work.

At the outset of the programme we had a number of advantages which helped the work to make good progress:

- There is a great deal of information available on Ruddy Duck numbers and distribution in the UK from the monthly Wetland Birds Survey and elsewhere.
- Ruddy Ducks are highly visible compared to many other species, especially during winter, and so are relatively easy to locate and count.
- A very large proportion of the UK population is to be found on a small number of "traditional" sites in mid-winter.
- After ten years of research into control methods, we had a good knowledge of the most effective methods of controlling Ruddy Ducks and the birds' behaviour and habits.

However there were also some significant problems which we have had to overcome, including the following:

- No powers of compulsory access – entry to sites is only possible with the agreement of the site owner or tenant.
- Hostility from some birdwatchers and local nature reserve staff.
- The need to minimise the disturbance to native species and disruption to other site activities such as fishing or sailing.

Ten full-time staff are employed on the project (eight shooting staff, one project manager and one footpath warden) and all are FERA employees. All are highly trained in both control methods and waterfowl identification.

The control strategy and Ruddy Duck behaviour

The regional control trials showed clearly that control of the wintering flocks, which make up a large proportion of the total population, was the key to bringing about a rapid reduction in numbers. In the case of breeding season control, there is evidence that if numbers are reduced on the best breeding sites, birds are drawn into these from suboptimal sites (CSL 2002). The strategy therefore has been to concentrate winter control on large wintering flocks, while breeding season control is concentrated on the best breeding sites.

The behaviour of the Ruddy Duck has favoured effective control, particularly in the winter, when shooting from boats is the most usual method. The large concentrations found on wintering sites fly readily when approached by boats, although individual birds are more likely to dive in order to escape. On most sites a number of boats form a line

across the water and as it approaches the flock the birds fly over the line and are shot with shotguns. It is relatively rare for Ruddy Ducks to leave a site when shooting is taking place. Any birds which manage to fly over the guns tend to regroup in another area, and the process is repeated. Besides shooting flying birds many birds are shot on the water surface either from cover on the bank or from the boats themselves (Fig. 5). The proportion of birds shot per visit depends on the nature of the site and the weather conditions, but typically 50–75% of the birds present are culled on any one visit. This proportion has risen in recent winters as the size of the flocks has fallen. Importantly, there is no evidence that Ruddy Ducks have abandoned traditional wintering sites to any great degree as a result of the disturbance caused by shooting.

Figure 5. The picture illustrates the use of small calibre sound-moderated rifles in the breeding season. Photo: Iain Henderson

During the breeding season the population is much more dispersed and birds tend to be found on smaller waters.

Most breeding-season control now involves shooting birds on the water surface using small-calibre, sound-moderated rifles which cause very little disturbance to other species. The main target at this time of year is breeding females with the aim of reducing productivity. It was considered possible that productivity would rise as the population fell and there was less competition for food and breeding sites, but this appears not to have happened to any significant degree.

Over 6,800 Ruddy Ducks have been culled since the eradication programme started in September 2005. However, since 2006 (when 2,290 were culled) the numbers culled annually have fallen in line with the overall decline in the population.

Monitoring of progress

National counts of key sites are carried annually by the Wildfowl & Wetlands Trust.

Since the first survey in January 2006 there has been a large decline in numbers seen, despite a doubling of the number of sites surveyed (Hall and Cranswick, 2010). It is estimated that by January 2010 the UK Ruddy Duck population had fallen to around 350 individuals, compared to between 4,000 and 5,000 at the start of the programme (Fig. 6).

The current population (March 2010) is estimated to be around 210 individuals.

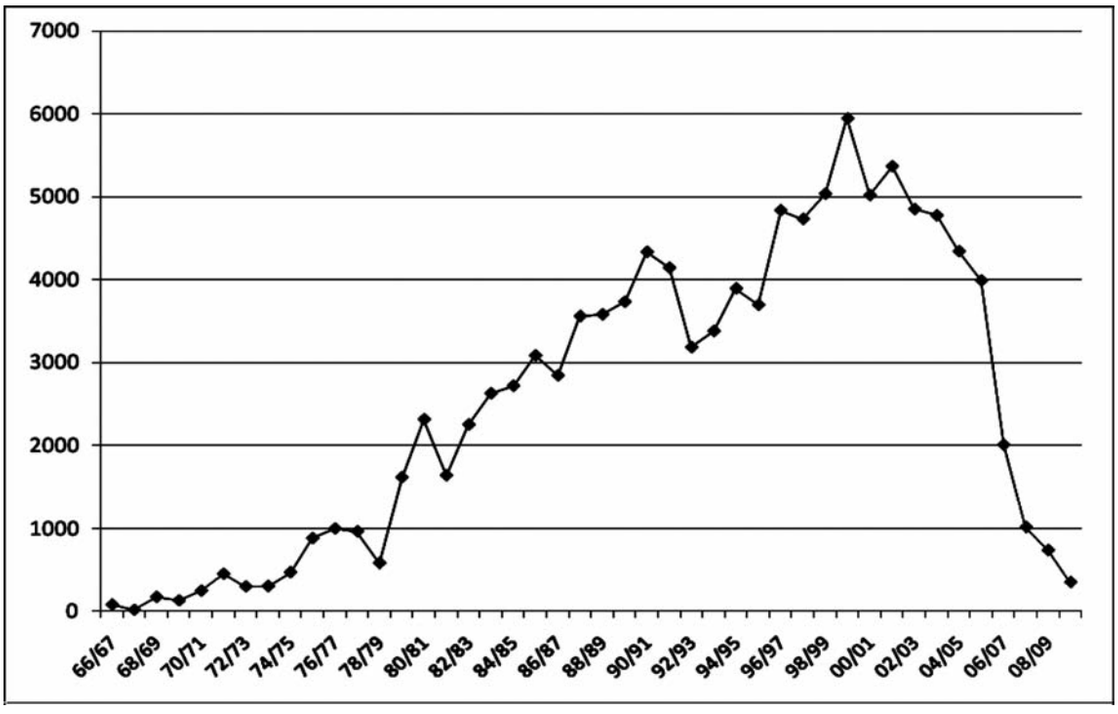


Figure 6. Approximate numbers of Ruddy Ducks in the UK, midwinter 1966/67 to 2009/10

Ruddy Ducks in Europe – the current situation

In order to completely remove the threat to the White-headed Duck it will be necessary to eradicate Ruddy Ducks throughout Europe and this will require the co-operation of other European Governments. In the last ten years the development of the populations in Europe has been patchy, and now only France, the Netherlands and possibly Belgium appear to have viable populations. The Netherlands had approximately 16–20 breeding pairs in 2008 (Erik van Winden pers. comm.) while France had around 40–60 breeding pairs in 2007 (Alain Caizergues pers. comm.). Ruddy Ducks in France are concentrated in the northwest of the country and numbers have continued to increase slowly, despite around 100–150 birds being culled annually in recent years. In the Netherlands, however, peak winter counts have stabilised in recent years, with a peak of approximately 85 birds in winter 2009/10. This followed several years of significant increases (Fig. 7) and has occurred without any control of the population in the Netherlands to date, suggesting that there may be movement of birds between south-east England and the Netherlands and that control of the population in the UK has been responsible for the slight decline in numbers. A similar link is suggested by the rapid decline in the number of observations of Ruddy Ducks in Sweden following the start of the UK eradication programme in 2005 (Fig. 8).

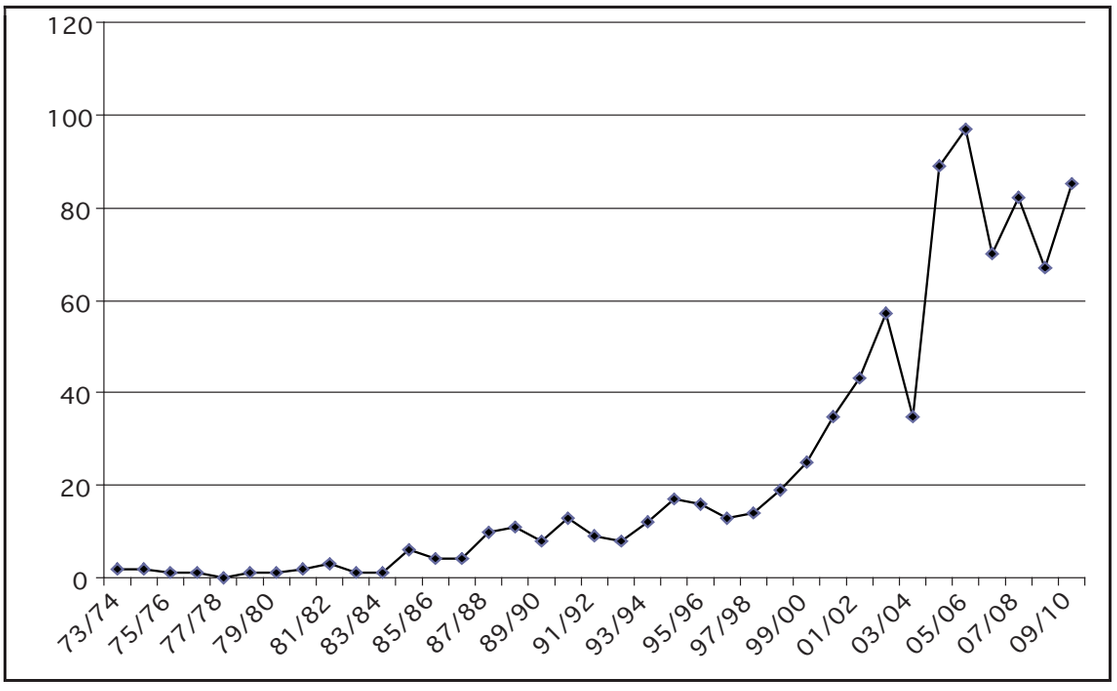


Figure 7. Peak numbers of Ruddy Ducks in the Netherlands, 1973/74 to 2009/10 (data for winter 2009/10 is provisional)

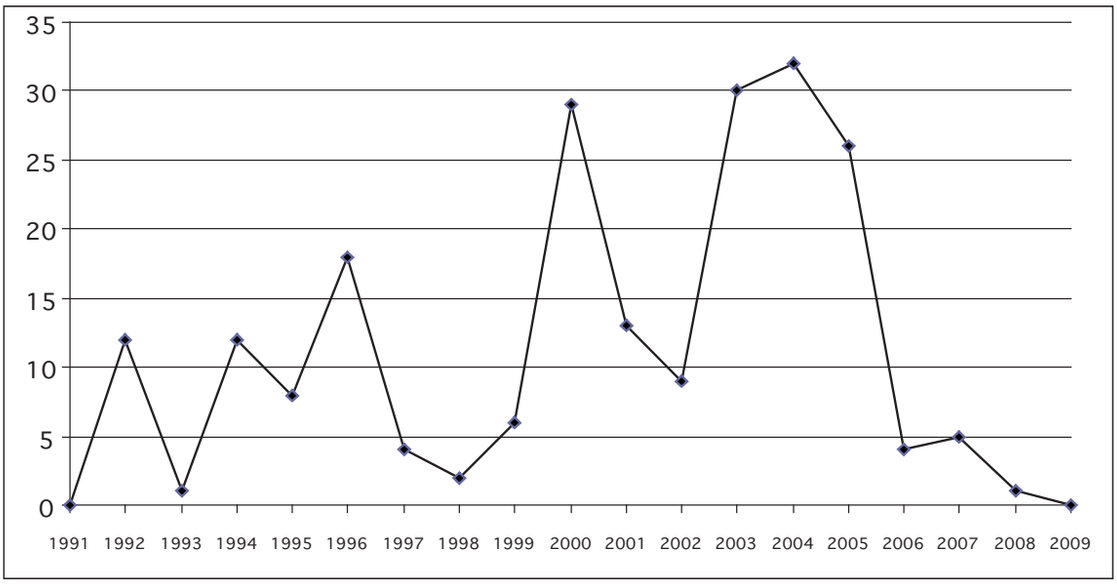


Figure 8. Observations of Ruddy Ducks in Sweden, 1991-2009 (data for 2009 is provisional)

Numbers of Ruddy Ducks in other European countries remain very low. In Belgium, one pair attempted to breed in 2006 and 2007 (Wouter Fayvets pers. comm.). In 2008, three pairs were recorded in a Special Protection Area at Antwerp Harbour, and seven young raised. Because of the presence of other breeding waterbirds (most notably a Eurasian Spoonbill *Platalea leucorodia* colony), the shooting of these birds was not possible. Up to five pairs were present in this area in May 2009 (Wouter Fayvets pers. comm.) and two adult males, three adult females and five pulli were shot in August 2009 (Hans van Gossum, pers. comm.). A small number of birds (approximately 10-12) overwintered in Belgium in 2009/10 so it appears likely that there will be further breeding attempts in 2010. Numbers in the Republic of Ireland appear to have fallen, in line with the decline in the UK population, and most records are now of single birds. Comprehensive data from Morocco are difficult to obtain but one possible Ruddy Duck x White-headed Duck hybrid was reported near Rabat, with two White-headed Ducks, in April 2009 (Ana Iñigo *in litt*.). In Germany, only one breeding pair has been recorded since 2000 – in Lower Saxony in 2001 2002 and 2003 (Gerhard Adams pers. comm.). Although there have been rare observations during the breeding season in northwest Germany in more recent years, no broods have been confirmed (Friederike Woog *in litt*.). It is believed that only one Ruddy Duck has been recorded in Iceland since 2004.

Conclusion

There is no doubt that the eradication of Ruddy Ducks from the UK is a difficult task. However, progress since the start of the eradication programme has been in line with expectations, with numbers falling by over 95% by March 2010. Ruddy Ducks have not become harder to find or cull since the start of the programme, nor have they abandoned traditional sites in response to culling. One of the main areas of concern now is the presence of Ruddy Ducks in other European countries. Eradication in these areas, particularly France and the Netherlands, must follow if the success of the UK programme is not to be compromised. The case of Ruddy Ducks can be seen as a test of cross-border cooperation in the control non-natives, and failure to act in other European countries may jeopardize similar work which might be needed in the future.

Acknowledgments

I would like to record my gratitude to all who have assisted the programme by allowing access and providing count data. Sincere thanks go to members of the Project Advisory Group for their advice and support over many years. Many thanks also to colleagues in other European countries for data, most notably Erik van Winden, Alain Caizergues, Wouter Fayvets, Hans van Gossum, Mario Saénz de Buruaga and Carlos Gutiérrez.

References

Central Science Laboratory (2002) UK Ruddy Duck Control Trial Final Report www.defra.gov.uk

Green AJ, Hughes B (1996) Action plan for the White-headed Duck *Oxyura leucocephala*. In:

Heredia B, Rose L & Painter M (eds.) *Globally Threatened Birds in Europe*: 119–146. Council of Europe Publishing, Strasbourg

Hall C, Cranswick PA (2010) Monitoring of the UK Ruddy Duck population during ongoing control operations: survey results winter 2009/10. Preliminary Report. WWT Report to the Food and Environment Research Agency

Hudson R (1976) Ruddy Ducks in Britain. *Brit. Birds* 69:132–143

Hughes B (1996) The Feasibility of Control Measures for North American Ruddy Duck *Oxyura jamaicensis* in the United Kingdom. WWT report to the Department of the Environment

Hughes B, Robinson JA, Green AJ, Li ZWD, Mundkur T, compilers (2006) International Single Species Action Plan for the Conservation of the White-headed Duck *Oxyura leucocephala.* CMS Technical series No. 13 & AEWA Technical series No. 8, Bonn

Hughes B, Criado J, Delany S, Gallo-Orsi U, Green AJ, Grussu M, Perennou C, Torres JA (1999) The status of the North American Ruddy Duck *Oxyura jamaicensis* in the Western Palearctic: towards an action plan for eradication 1999–2002. Council of Europe Publication T-PVS/Birds (99)9, Strasbourg

IUCN (2009) Red List of Threatened Species. Version 2009.1. www.iucnredlist.org

Kershaw M, Hughes B (2002) The Winter Status and Distribution of Ruddy Ducks in the UK 1966/67–1999/2000. Report to the Department for Environment, Food and Rural Affairs

McCracken KG, Harshman J, Sorensen MD, Johnson KP (2000) Are Ruddy Ducks and White-headed Ducks the same species? Brit. Birds 93: 396–398

Morley E (2003) Parliamentary Statement on Ruddy Duck control by the Parliamentary Under-Secretary of State for Environment, Food and Rural Affairs. The Official Report (Hansard), House of Commons, London, 3 March 2003

Muñoz-Fuentes V, Green AJ, Sorensen MD, Negro JJ, Vilà, C (2006) The Ruddy Duck *Oxyura jamaicensis* in Europe: natural colonization or human introduction? *Molecular Ecology* 15:1441–1453

Torres JA (2003) Las Malvasías cordobesas veinticinco años después. Diputación de Córdoba, Departamento de Medio Ambiente y Protección Civil

Wetlands International (2006) *Waterbird Population Estimates.* 4th edn. Wetlands International, Wageningen

Iain Henderson
The Food and Environment Research Agency, Sand Hutton, York YO41 1LZ

Managing Biodiversity Risks of Biofuels – Biological Invasions

Geoffrey W. Howard

The world-wide movement to produce biofuels as substitutes for reducing stocks of fossil fuels has resulted in many plantations in developing countries of introduced plants used as feedstocks for production systems. Amongst the negative impacts of establishing biofuel production systems in single-species plantations is the probability that they will result in biological invasions by the introduced plants if they "escape" from the production area. IUCN initiated a programme to investigate the likelihood of this happening in Eastern and Southern Africa and, after two significant consultations with biofuel producers, government regulators, invasive species experts and concerned conservationists, developed a series of recommendations on how to reduce or eliminate the risk of possible invasions by the introduced plants. The result was a series of recommendations and best practice which will enhance the existing advice on prevention of invasions of the Roundtable on Sustainable Biofuels. The process and outputs of those consultations are described and links to their details provided.

Introduction and background

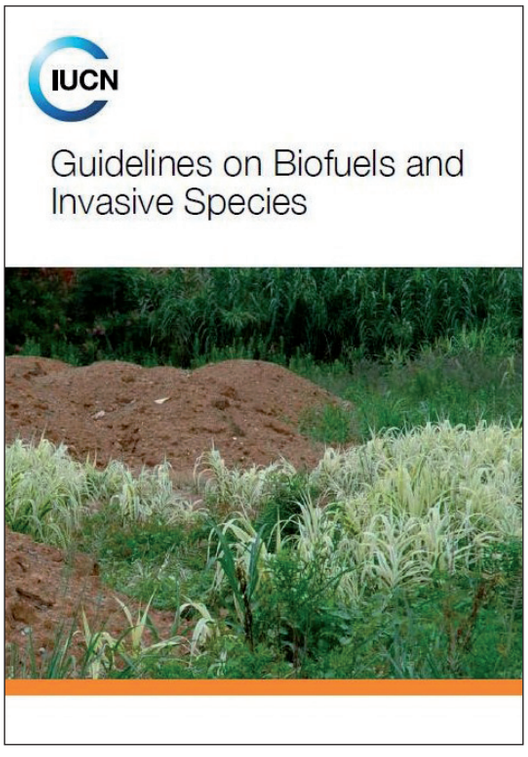
During the 9th Conference of Parties of the Convention on Biological Diversity (held in Bonn, Germany in May, 2008), the Global Invasive Species Programme (GISP) hosted a Press Briefing on Biofuels and Invasive Species and released a small information document entitled "*Biofuel Crops and the Use of Non-Native Species*". The gathering was addressed by the Chairman of the GISP Board, Dr Dennis Rangi, and by GISP partners from CABI, IUCN and The Nature Conservancy. They presented possible problems of biological invasions from plants introduced from outside a particular area that would be used as feedstocks for biofuel plantations – especially in developing countries, and then contributed some solutions to this problem. The result was a plethora of press articles across the world and much debate about whether this was really a significant risk and what could be done about it – especially as large areas of land were being purchased in Africa, Asia and Latin America for the development of biofuel plantations at that time. GISP responded by publicising the information document (GISP, 2008) and encouraging the preparation of a technical paper on the subject which was subsequently published in Biodiversity Business (Howard G & Ziller S, 2008) later that year. This presented the possible problems as well as ways to avoid them and suggested that Weed Risk Assessment should become a standard practice when deciding upon the kind of biofuel feedstock to select for a production system.

IUCN, through its Business and Biodiversity Programme and its Invasive Species Initiative, decided to take this further and to assist the Roundtable on Sustainable Biofuels to develop specific guidance for the selection and management of biofuel plantations to avoid the possibility of plant invasions from the feedstocks involved. A proposal was made to the David and Lucile Packard Foundation which generously agreed to fund a one-year set of activities to prepare some of the guidance suggested. This was to be done by gathering information and advice and discussing this in the Eastern and Southern African region with interested parties, experts and biofuel producers. This region was chosen for the discussions because of the rapidly expanding biofuel industry developing in that part of Africa at the time.

The Process – Workshop One

The first activity of the one-year project was to commission a background document which would define the terms and the topic and give general information necessary for an informed discussion about this topic. Dr John Mauremootoo was asked to prepare such a document (IUCN, 2009a) which was finalized in March, 2009 and distributed to the participants who had meanwhile been invited to the first

workshop. This was held at the offices of IUCN in Nairobi, Kenya, from 20th to 22nd April involving 18 people from Ethiopia, Kenya, South Africa, Tanzania, Uganda and Zambia with a West African participant from Burkina Faso and two colleagues from UK and Switzerland. Those attending the workshop were from government agencies, non-government organizations and the (biofuel) private sector with expertise and experience in biodiversity conservation, biological invasions, alternative energy sources, research and biofuel production systems in this region of Africa.



This first workshop had five objectives:

- To appreciate the need for biofuels as alternatives to fossil fuels
- To gain some general idea of biofuel developments in the eastern and southern African region
- To raise awareness among biofuel policy makers and investors of the invasive species risks of biofuel plants
- To raise awareness among those involved with invasive species about biofuel systems and risks associated with impacts of biofuel developments
- To identify lessons and tools to manage the risks

These objectives were all achieved through presentations, discussions and the drafting of some first set of guidelines developed as lessons and tools during the 2.5 days. All of this information, including a workshop report and draft guidelines are available on the IUCN website at
http://www.iucn.org/about/work/initiatives/energy_welcome/energy_impacts/energy_bioenergy/biofuel_invasives/
under "1st Workshop on Invasive Species and Biofuels".
The draft guidance that was produced from the workshop was then placed on the IUCN website and advertised widely for comment for several months – allowing the opinions of other interested parties to be incorporated. These were incorporated into a subsequent draft which was the subject of the second workshop.

Workshop Two

This second workshop was held at the same venue as the first on 5th and 6th October, 2009 and included 18 participants from the same range of countries as in the first workshop – but covering a wider group of interests including government agencies responsible for biofuels and alternative energy policies, civil society organizations promoting biofuels and a private sector organization providing finance for biofuel production developments – in addition to biodiversity conservation and invasive species expertise and environmental regulatory bodies.
The meeting was also fortunate enough to be able to bring a representative of the Roundtable for Sustainable Biofuels from Switzerland to both advise the workshop and to contribute to the discussions and take away a finalised product (as far as possible).

The objectives of this meeting were:

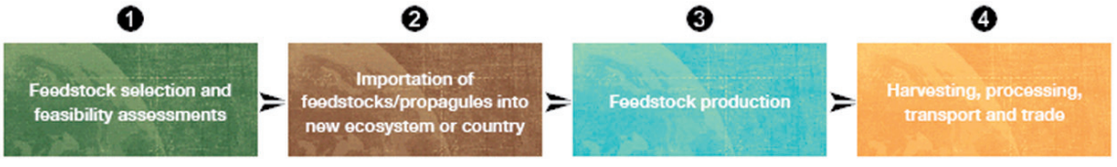
- To consult with different sectors to identify possible weaknesses and objections that could undermine the proposed guidelines
- To identify which groups may use the guidelines and in what ways
- To identify what information would be needed by different users to complement the guidelines and maximize their efficacy
- To test the guidelines, possibly with a set of different scenarios of potential uses
- To follow-up with a refined set of guidelines

Again the objectives of the workshop were largely realized, especially in as much as a final set of agreed guidelines was discussed, prepared and drafted for publication. As before, the process, presentations and discussions of the meeting were described in a second workshop report which was posted on the IUCN website next to the first report (above).

Most importantly, the proposed guidelines were then reviewed by the IUCN team and prepared as an official publication of the year-long process and this was placed on the IUCN website in early 2010 (IUCN, 2009b). The guidelines were then officially launched in hard copy at the WINROCK India meeting on biofuels on 12th February, 2010.

The Guidelines

The guidelines (resulting from the steps described above) are based around the four identified stages along the supply chain of biofuel production from plantations of introduced plants which were described throughout the workshops and guidelines as:



In this way the process was able to provide guidance for each stage which is described in detail in the published document. A summary of these guidelines for each of the 4 steps follows:

1. Planning: Stakeholders involved in the production of biofuels from introduced plant feedstocks should conduct a **cost-benefit analysis** that includes the potential costs of a consequent invasion. Governments should develop **strategic environmental assessments** to plan biofuel production at national level while developers and investors should conduct **environmental impact assessments** at project level that would include **weed risk assessments** of the species concerned. These plans should be underpinned by contingency funds set aside as insurance for any necessary remedial actions in the future as well as a commitment from the outset to be vigilant to the possibility of a biological invasion, and willingness to take measures to prevent its spread from the production system.

2. Importation: Importation of feedstocks and their plant propagules should occur within a suitably robust quarantine system which needs to be prepared to inspect and approve/prevent unwanted or unlicensed species. Governments should strengthen their capacity to monitor and enforce phytosanitary regulations and base polices on feedstock imports on sound ecological policies. Developers and investors should comply with all national regulations relating to the importation of live plants or their propagules. This includes the possible introduction of pests and diseases associated with the feedstocks.

3. Production: Feedstock plantations should only be developed subject to the preparation, submission and implementation of an Environmental Management Plan (EMP). Such plans should include:

- Detailed best practices to be followed
- A contingency strategy to manage a possible "escape" of a biofuel plant species or a pest or disease organism that could become invasive
- Provision of a contingency fund to support eradication, containment, management or restoration
- Preparation and implementation modalities for a monitoring system to check for feedstock "escapes" and the presence of pests or pathogens emanating from the biofuel plantation.

EMPs should be audited by a neutral third party with the relevant expertise.

4. Transportation/Processing: Risks of invasion related to transport and processing of feedstocks should be minimized by reducing the distances that viable plants and propagules are moved; meanwhile, conversion of feedstocks should occur on-site of the plantation if possible. Governments and developers should ensure adequate monitoring of transport vehicles for the presence of seeds, feedstock plant remnants and pests. All stakeholders should promote awareness of the risks associated with biological invasions and the need for vigilance in ensuring that introduced plants do not initiate invasions and that there is a robust monitoring system to detect any signs of invasions – particularly in susceptible habitats.

Five key recommendations: In addition to the main guidelines, the publication describes five practical key recommendations for biofuel producers and processors using introduced plants as feedstocks.

These are:

1. Follow a precautionary approach when choosing feedstocks
2. Work with stakeholders to build capacity
3. Comply with local, national and regional regulations
4. Develop and follow Environmental Management Plans
5. Extend planning, monitoring and assessments beyond the field.

The Roundtable on Sustainable Biofuels: The Guidelines also describe the impacts of this yearlong process on the Roundtable on Sustainable Biofuels which now has a similar set of minimum requirements and operating principles for avoiding the risk of biological invasions during biofuel production and processing. These are outlined in the published document.

Acknowledgments

The interest and financial support of the David and Lucile Packard Foundation was essential to this process and is gratefully acknowledged. The IUCN team of Sam Keam (our reliable and efficient consultant), Nadine McCormick and Andrea Athanas (of the IUCN Energy Group of the Business and Biodiversity Programme) and the support from the ESARO colleagues at the IUCN Wasaa Office in Nairobi, including Esther Abonyo of the Invasive Species Initiative, are thanked for their continuing support and efforts to make this a year of useful outputs and awakening in this corner of biodiversity conservation. Similarly the participants at the two workshops and the folks who responded to our call for comment on the first draft of guidance are recognised for their essential role in the process.

References

GISP (2008) Biofuel crops and the use of non-native species: mitigating the risks of invasion. 8pp., available at: *http://www.gisp.org/publications/report/BiofuelsReport/pdf/pdf*

Howard G, Ziller S (2008) Alien alert – plants for biofuel may be invasive. Bioenergy Business, July/August 2008:14-16

IUCN (2009a) Biofuels and Invasive Species. Exploring the links between biofuel production systems and invasive species. Prepared by John Mauremootoo, 23 pp. pdf available at: *http://cmsdata.iucn.org/downloads/biofuels_and_invasives_background_paper.pdf*

IUCN (2009b), Guidelines on Biofuels and Invasive Species. Gland, Switzerland: IUCN, 20pp. available in pdf at *http://cmsdata.iucn.org/downloads/iucn_guidelines_on_biofuels_and_invasive_species_.pdf*

Geoffrey W. Howard
IUCN Coordinator for Invasive Species
IUCN Invasive Species Initiative
IUCN Global Invasive Species Programme
IUCN Nairobi, Kenya
E-mail: *geoffrey.howard@iucn.org*
E-mail: *g.howard@gisp.org*

Biosecurity in the New Bioeconomy: Threats and Opportunities

Andy Sheppard

In November 2009 the OECD Cooperative Research Program and CSIRO co-sponsored an international summit in Canberra Australia on policy and research on the environmental, agricultural and human risks posed by new non-food crops being promulgated and increasingly globally planted for biofuel and bio-industry purposes. The summit was to debate and define issues and recommendations that would help address the current lack of consideration of the biosecurity down-sides of this new 21st century agricultural revolution. Huge government subsidies and industry funding are going into the development of such crops for planting huge areas in the developed, developing and under-developed world. Little consideration is given to the potential harmful legacy this could leave through a) new invasions from abandoned trials and escapes from plantations, b) the capacity for such new crops to multiply pests for surrounding food crops and c) the impacts toxins and allergens from these plants could have on local ecosystems and human communities. Little thought has been given internationally to any sustainability principles and government policies are way behind in being able to carefully manage this change. The summit developed a statement of issues and recommendations and called for an international effort in addressing these problems particularly for protecting developing countries from the real risks being taken.

Introduction

Crop-based biofuel production has grown exponentially, driven by government policy interventions to achieve national targets and venture capital investments. This urgency may lead to compromise of the biosecurity of current and future agricultural production systems. These issues also arise with the entrepreneurial development of new bioindustry-focussed GM crops for high value industrial and pharmaceutical compounds Climate change and prospects of a future emissions constrained economy are driving this development of novel non-food crops and varieties in new areas, coupled with a mix of sovereign state energy security, domestic agricultural and innovation policy and responses to recent and potential future crude oil pricing. New species and varieties are being commercially fostered around the world to develop and reinvigorate the global agro-forestry industries. First, second and third generation biofuel solutions are in various stages of production. Their true dollar and carbon-based economic viability is unclear due to government subsidies along the value chain and some crop production systems are failing commercially and environmentally due to limited to no consideration of associated biosecurity problems. While these novel crops and broader-scale planting of adapted varieties of existing crops for new purposes are on the increase, the associated biosecurity risks have been largely ignored. Novel agriculture in the 21st century must be based on triple bottom line principles. There are two key biosecurity issues:

- Novel crops in both current production systems and new regions pose significant invasion threats to human health, agriculture, biodiversity and natural ecosystem services through
  – uncontrolled allergen and toxicity associated impacts on human wellbeing
  – abandoned trial plantings of uneconomic varieties and
  – feral individuals (or invasive species) from economically viable plantations invading agricultural and natural landscapes.
- Novel crops will also have suites of pests, weeds and diseases that will
  – impact pest management systems in neighbouring crops and
  – require innovative environmentally sustainable IPM technologies to ensure triple bottom line production viability

An OECD sponsored conference, *Biosecurity in the new Bioeconomy***,** was organised at Australia National Academy of Sciences building by CSIRO to explore how research and policy can contribute to the

development of new sustainable cropping systems for new biomass feedstocks and bioindustries that provide new opportunities while posing only easily manageable economic, social or environmental challenges. This was the first international conference to focus on the broad biosecurity consequences of 21st century non-food agriculture. Through workshops and public forums the enormous opportunities novel crops offer sustainable integrated pest management strategies to deliver sustainable profitability for these new industries were discussed.

Attended by a wide range of international delegates and invited speakers from government, science agencies and industry, the outcomes were focussed through two public forums and two summary workshops on future directions for policy and research and development in biosecurity for the emerging bio-energy and bio-engineering non-food cropping industries.

Weedy biofuels: should we be worried?

The first public forum debated *Weedy biofuels: should we be worried?* While many proposed new biofuel species have weedy characteristics and widespread plantings will increase such risks, proposing blanket bans is neither pragmatic nor politically palatable. Governments recognise the social benefits of new industries and need for energy self-sufficiency. Although they have the power to regulate the use of invasive species, effective policy relevant for conflict cases, in which the risks and benefits are borne by different sectors, remains elusive. Bio-energy feedstock production on marginal land with biodiversity value is one such future conflict.

The current carbon price and offsets for coal and gas prevent economic biofuel cropping without subsidies. The taxpayer therefore currently provides both the private benefits (profits) and insures the risks (cleanup costs) for industry. As biofuels cannot mitigate climate change, there need to be national strategies around biofuel and bio-energy with mandatory and public risk-cost-benefit analyses for the industry. Case-by-case species and context specific proposals should be placed in a broader strategic framework of risk assessment. Nonetheless biofuel crops could generate net benefits when a) the species clearly satisfy risk assessments (RA's), b) they generate lower CO_2 emissions per unit energy than alternatives and c) offer useful agro-ecosystem services e.g. N retention or increase biodiversity. The key is to identify niches where there are win-win solutions for the landscape.

Developing countries tend to follow others when recognising high risk species, but they need context specific RA of proposed new crops. Ecological RAs should go beyond simple hazard identification to be part of a mutual education process. The hazards may be much broader than the weed risks themselves, as impacts are often indirect and unpredictable (high uncertainty) involving ecological cascades and feedback loops. This makes them hard to clearly capture in regulations. Post-border weed risk assessment (WRA) needs to parallel other RAs (genetic RAs, pathway RAs) within the context of a desired endpoint (protecting biodiversity) and/or a specific spatial scale (different land-use types). Other risks include pest drift; new crops as corridors or stepping stones for pests and diseases into current cropping systems (eg. sugarcane smut in Australia) and the consequence of GM varieties on genetic pollution and biodiversity through changing practices and landscapes.

A move away from investor-driven planting of exotics in developing countries to consider native species for biomass or bio-energy production may provide multiple benefits. Oil mallee trials on ex-cropping and degraded land in Western Australia are generating feedstock to supply energy to the grid, activated charcoal and eucalyptus oil. Other less tangible benefits arise for water balance, aboriginal employment, and increased biodiversity benefits. Similar trials are underway in New Zealand. Benefits are lost if land is cleared for plantings to meet industry economies of scale. Long-term business plans do not yet adequately incorporate risk and there remain major hurdles around market access efficient harvesting systems. Another risk is that growers will want improved hybrids that could generate new genetic risks unless mitigated through planting away from relatives. The use of native flora in the developing world may also provide sufficient benefits, even if there remain residual risks. There are many specific needs in the petroleum substitutes markets and higher revenues can be achieved if substitutes for high value components can be sustainably integrated into course biofuel production systems.

New crops, new pests

The second public forum addressed the problems of *New crops, new pests.* Most new agricultural cropping systems fail to pro-actively plan for losses to pests and diseases. Many new crops (eg. poplars for bio-energy feedstocks in New Zealand or Australian cedar plantations) or new crop rotations (soybean – sugarcane) have failed as a result, undermining whole industry viability. Government subsidies and research support is too focussed on the production side and farmers rather than business managers should be making the early decisions.

GM crops forced governments and industry to consider ethics and community participation, helped by simple messages and scenario mapping. Given the unprecedented scale of the expected changes that are coming, policy makers that subsidise biofuel cropping and regulate new industrial crops can use this past experience (e.g. with Bt Cotton) to include similar sustainability and IPM imperatives.

In Brazil a switch of sugar cane to biofuel production was simple because the IPM strategies were in place, although sustainability issues remain around further land clearing. Scientists and the contractors who grow the new crops are likely to have the background expertise, but to develop IPM systems *de novo* requires high investment for fledgling industries and strong levels of science and industry cooperation.

New crop profit levels dictate the capacity for IPM, so, while biofuel crops are supported by government subsides and buy back guarantees there will be little capacity for pre-planting proactive pest management research and maintaining healthy sustainable landscapes. This highlights the folly of linking biofuel production to "marginal land". Here production too will be marginal and impacts on biodiversity more significant. The business case for algal biofuel is more impressive. Scenario mapped yields, outcomes and endpoint products directly attracted BP and Shell. Higher value crops for expressing key industrial compounds and polymers are coming and these too would have the margin required for sensible pro-active IPM. However, a viable and sustainable bio-energy feedstocks strategy built on low value new biofuel crops seems both delusionary and a likely source of long-term environmentally harm.

A general consensus is a need for a global future vision and plan for agriculture to support the expected "green revolution" increasing the role of agriculture in the GDP of developed and developing countries through higher value production systems, while providing social development and protection of ecosystem service and function. Shifting agriculture to developing countries should not be because of weaker sustainability criteria. Scenario planning around future carbon sources, of which agriculture is only a part, can be assisted by multi-disciplinary research agencies.

Policy summary workshop

Future directions needed for policy recognised the strategic need for national policies to plan and oversee the implementation of bio-energy and bio-industry cropping systems. This should capture the context for a comprehensive risk analysis (user pays) for quarantine requirements for importation, initial field trials (as for GM) and pre- and post border management guidelines (e.g. like South Australia has done for *Arundo donax*). Benefits also need to be considered. Proposals should be considered based on a business case that captures long-term economic viability (beyond government subsides) and the potential scale of production based on realistic assessments of the amount of available land. The potential impacts could be addressed by an Environmental Impact Statement (EIS) that has on the ground consideration of 1) direct risks of biological invasions in the proposed regions and the scale of production even if species is already present in the country (e.g. large plantings of *Pomgania* into northern Australia), 2) food security- direct competition with food cropping, 3) likelihood of pests impacts (statements that new crops would be pest free e.g. Jatropha have proved a fallacy) 4) likely indirect economic impacts from new crops acting as a pathway and source of pests for existing agriculture based on the proposed scale of production, 5) likely social impacts; e.g. toxins, allergens and GM on local communities and contamination of food supply chains, 6) scaled environmental impacts, pollution, fire frequency/intensity, water resources, desertification, land degradation, other ecosystem services, and 7) consequences under climate change.

International policy standards, best management practices and agreement mechanisms are needed for assisting developing economies and under developed countries with defining high value bio-energy and bio-industries when approached by investors for plantations and for imports and exports. First step would be standards for national policy development, regulatory processes, infrastructure and capacity building for sustainable land use for non-food crop production prior to government/industry initiating bio-energy/industry production systems. EIS and WRA could be adapted for such countries for rapid risk screening/ranking of proposed new species importation and planting including the inclusion of scaling issues and indirect effects (as above). Standards should also incorporate existing standards on effective and flexible quarantine systems, given lack often poor capacity for prevention, and on use of GM technologies likely to be more widely applied to add value to non-food cropping. These would add to the existing International Plant Protection Convention standards linked to the Convention on Biological Diversity and run through regional plant protection organisations.

International and national based certification schemes for sustainability of bio-energy imports/exports (similar to wood product certification) could follow from effective EIS mechanisms based on car-

bon footprint and regional environmental impact profiles.

R&D summary workshop

The role of science in supporting the new Bioeconomy depends on how different future agro-forestry production systems will be. Will non-food and food cropping systems be integrated e.g. the same crops – sugarcane, maize etc? Will non-food agro-forestry become more perennial and move to more marginal land (become less intensive) and generate novel ecosystems, increase landscape fragmentation, adopt new native versus exotic species or GM approaches? Will NRM imperatives be carbon or water driven? There is a need for national/regional science-based strategic planning that takes into account the broader biosecurity concerns (risks of invasions, ensured sustainability and conservation values). Regional political imperatives around resource availability, GM and triple bottom line and land values will provide the context as must the product-driven business cases. The likely speed of change will also drive scientific imperatives. Science can already assist national and regional governments in their clarity of purpose and what to grow where for regional biofuel land use planning and industry in developing the safety side of ecologically sustainable business cases for particular non-food product development. Specifically science input can come through economic and environmental decision-tools such as risk/scenario/surprise analysis, landscape and production system models; Bayesian nets and industry standards like BOSCARD (Background, Objectives, Scope, Constraints, Assumptions, Reporting, Deliverables).

R&D can assist economic, environmental and social perspectives of biosecurity in future agro-forestry production systems. Science is already increasing economic efficiency by identifying whole of production system synergies. French bio-refineries minimise waste through maximising linkage across the profit spectrum of products through explicit interdependence. Science can inform government investment (subsidies, buy back schemes) to ensure new industries address biosecurity and maintain long-term sustainability. Ecological as well as economic viability/sustainability analysis of potentially moving production systems onto marginal lands can predict capacity to conserve biodiversity values and ecosystem function and undertake natural resource management (biological invasions, water and soil conservation). Landscape scale integrated management systems can assist with pests weeds and diseases pre- and post-harvest across food and non-food cropping systems. Science can also inform human health risks and lead change management around the social imperatives of changing production systems; extension/education for novel crops and associated IPM.

Conclusions

The conference concluded around some take home messages relevant for the OECD, IPPC, CBD and international and national plant protection organisations

- While government subsidies assist start up of new bio-based industries, viable and sustainable bio-energy feedstocks strategies will not result from low value new biofuel crops on marginal land, because the resulting marginal yields prevent necessary investment in sustainable IPM systems and insurance against environmental clean up when crops escape field boundaries
- Strategic national policies, decision making processes and regulatory procedures are currently inadequate to plan and oversee the implementation of bio-energy and bio-industry cropping systems. These are needed to:
  - support the necessary environmental impacts statements or risk analyses,
  - evaluate the business cases beyond subsidies and in relation to scale and availability of productive land,
  - define quarantine requirements for importation, initial field trials (as for GM) and pre- and post border management guidelines,
  - structure the cost sharing of risk management and
  - manage potential conflicts between the agricultural and other environmental and human health sectors.
- Governments experience with GM regulation provide a good basis for assessing risks from agro-forestry-based bio-energy and bio-industry production systems. These risks include:
  - direct risks of biological invasions in the proposed regions and the scale of production,
  - food security- direct competition with food cropping,
  - likelihood of pests impacts,
  - likely indirect economic impacts from new crops acting as a pathway and source of pests for existing agriculture,
  - social impacts; e.g. toxins, allergens and GM on local communities and contamination of food supply chains,
  - scaled environmental impacts, pollution, fire frequency/intensity, water resources, desertification, land degradation, other ecosystem services and
  - consequences under climate change.
- Bio-energy crops could generate net benefits when the species a) clearly satisfy risk assessments (RA's), b) generate lower supply-chain CO2 emissions per unit energy than alternatives, c) pro-

duction is integrated with higher value energy or fuel production systems allowing minimisation of waste and c) offer useful agro-ecosystem services e.g. N retention or increase biodiversity. The key is to identify landscape niches where there are win-win solutions.

- Bio-energy production systems based on native species are likely to be more sustainable, present fewer environmental risks, appear to offer multiple benefits including a greater capacity to support indigenous communities
- A global future vision and plan for agriculture is needed to support the expected "green revolution" increasing the role of agriculture in the GDP of developed and developing countries through higher value production systems, while providing social development and protection of ecosystem service and function
- Developing countries need international assistance to avoid poor decisions around implementation of these new industries. Additional international IPPC phytosanitary standards on risk-benefit analysis for managing the opportunities non-food agro-forestry presents are needed that should include, national policy and regulatory development and capacity building, best management practices, environmental impact, weed risk assessment, and benefit cost analysis
- A certification scheme addressing carbon footprint and environmental sustainability would assist such industries in national and international trade similar to that being developed for the wood products sector
- Science can assist and inform;
  - national and regional governments in their clarity of purpose, investments (subsidies, buy back schemes), human health risks and what to grow where, to ensure new bio-industries address biosecurity and maintain regional long-term land use sustainability
  - industry in developing the safety side of ecologically sustainable business cases
  - Government and industry in landscape scale integrated management systems for pests, weeds and diseases, pre- and post-harvest across food and non-food cropping systems and associated extension/education needed for IPM in novel cropping systems.
- Outreach requirements
  - Locally appropriate outreach efforts and community empowerment materials are needed to convey the benefits, risks and costs of developing a new bioeconomy. These must include environmental and social consequences to enhance making informed decisions.
  - Regional facilitators are needed to integrate current science and develop relevant and balanced training materials for the public. Concise fact sheets can present what is known, what needs further study and opportunities to pursue sustainably and address long-term costs as well as the short-term gains of shifting production to a bioeconomy.

Andy Sheppard
Leader, Invasive Species & Plant Biosecurity Theme. Entomology CSIRO
Phone: +61 2 6246 4198
E-mail: *andy.sheppard@csiro.au*

Introduced rats on Guafo Island (Chile) and their potential impact on Sooty Shearwater *Puffinus griseus*

Felipe N. Moreno-Gómez, Ronnie Reyes-Arriagada & Roberto P. Schlatter

*Seabirds nesting in island ecosystems are highly vulnerable to introduced predators. Sooty Shearwater (*Puffinus griseus*) form large breeding colonies in southern islands of Chile, South America. However, there are not studies determining the threat degree to this seabird associated to this kind of predators. This article reports the presence of introduced rats in the largest colony of sooty shearwater in the world (Isla Guafo, Chile), discussing the potential impact generated by rats over seabirds.*

Introduction

Seabirds that inhabit and breed on islands are highly vulnerable to predation by introduced mammals such as rats (*Rattus rattus*, *R. norvegicus* and *R. exulans*) (Jones *et al.* 2008), mice (*Mus musculus*) (Wanless *et al*. 2007) and feral cats (*Felis catus)* (Imber 1975). The impact of this predation is particularly acute on islands that lack any native mammalian predators and, as a consequence, the seabirds have limited or non antipredatory strategies (Dulloo *et al.* 2002).

Figure 1. Adult sooty shearwater

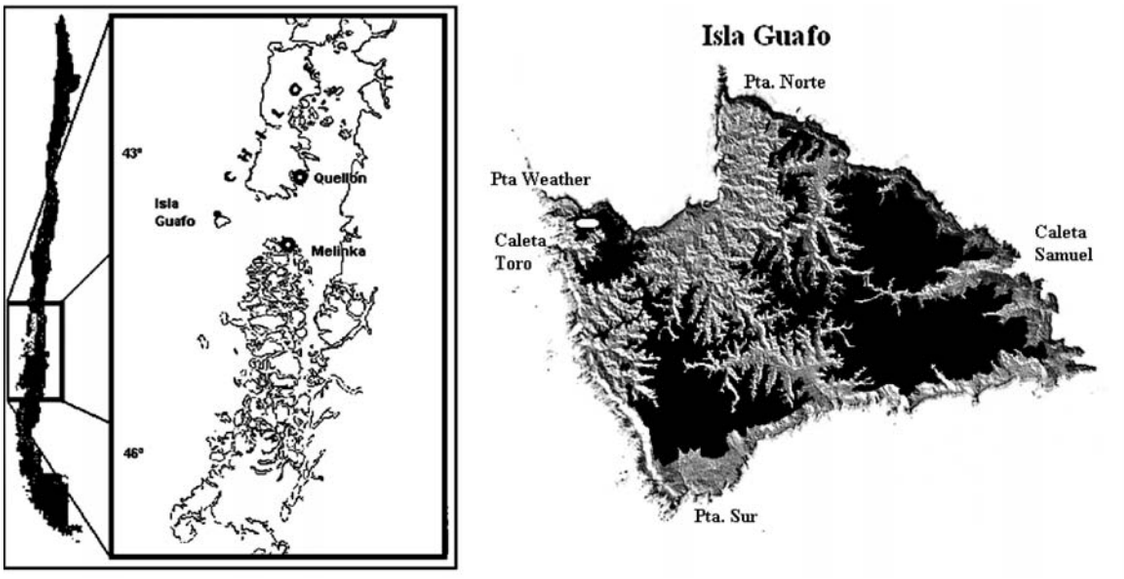


Figure 2. Geographic location map of Guafo Island, Chiloé, Chile. The black areas represent the total surface above the 150 meters above sea level, which correspond to the sooty shearwater nesting areas. The white ellipse highlights the surveyed zone

The sooty shearwater *Puffinus griseus* (Gmelin, 1789; Procellaridae) is a medium-size seabird that nests in burrows located on islands around South-America, Australia and New Zealand (Fig. 1). It breeds in colonies between October and May then migrates to the northern hemisphere during the austral winter (Briggs & Chu 1986, Cooper *et al*. 1991, Spear & Ainley 1999). In New Zealand this species breeds on small and large colonies in a large number of islands (Hamilton *et al*. 1997), reaching 2.75 millions of individuals on Snares Island (Warham & Wilson 1982). There are a total of 20 million pairs estimated in this region (Robertson & Bell 1984). There are also small colonies in southern Australia with approximately 2,000 birds in the largest (e.g. Spear & Ainley 1999).

In relation to the conservation status of *P. griseus*, the IUCN (2009) classifies this species as "near threatened". There is a large body of published information about the breeding colonies from the western Pacific Ocean, establishing that the population is still decreasing both in their nesting areas as well as in their migratory sites (Hamilton 1997, Veit *et al*. 1996, Scofield & Christie 2002, Uhlmann 2005). A traditional harvest of sooty shearwater chicks by Maoris occurs just before fledging on the islands adjacent to New Zealand. However it is still unknown if this activity is sustainable in the long-term (Gaze 2000, Clucas *et al*. 2008) due to factors such as climatic fluctuations, by-catch (Uhlmann 2005), social and technological change (Lyver & Moller 1999), predation by introduced mammals like dogs (King 2005), stoats (Lyver *et al*. 2000), cats (Brothers 1984) and rats (Gaze 2000, Jones 2000, Harper 2007), all of which may have an impact on population dynamics. For instance, due to the decreasing birth rate that has been observed for many decades on Titi island, New Zealand, the hunting of these seabirds was banned and successful rat eradication campaigns were performed due to their predatory impact on the breeding colonies (*R. norvegicus* (Berkenhout 1769) during the 1960s and 70s) (Gaze 2000).

Figure 3. Chick of sooty shearwater in the burrow nest chamber

Contrary to the New Zealand and Australia scenario, there is scarce information about *P. griseus* population status for the austral islands of South America. However, it is estimated that Chile has the greatest world population of this species (Reyes-Arriagada *et al*. 2007). Reyes-Arriagada *et al*. (2007) indicated that the biggest colony of *P. griseus* in the world is located on Guafo Island, Chile with four million pairs. In 2004 these authors also reported the presence of rodents and feral cats on the island, without information about the rat species. There is no harvest activity of *P. griseus* chicks. This means that the potential impact of these introduced species could be one of the main problems that this breeding colony is facing. The aims of this work were to identify specifically which species of rats live on the *P. griseus* colony on Guafo Island and to search for signs of predation by rats.

Materials and Methods

Guafo Island is located in the Pacific Ocean in front of the Chilean south coast (43º 61' S; 74º 75' W), at approximately 120 km from the shore (Fig. 2). It has an area of 299 km^2 and raises to 306 m. a.s.l. at its highest point. The *P. griseus* colony is located at 150 m. a.s.l and occupies about 84.411 km^2. Burrows are located along the steep slopes formed by numerous mountain ranges. These slopes predominate in the area and flat land is almost absent (Reyes-Arriagada *et al*. 2007). Floristic composition corresponds to Laurifolio forest of Chiloé.
During ten days in January 2006 (a period at which all chicks have been hatched and begun their development, see Fig. 3), a grid with 16 snap traps was set, each trap were placed within 10 m of each other, covering a 900 m^2 area. Traps were covered with a protection device made of wood in order to avoid capturing non-target species (Fig. 4). Rolled oats were used as bait. All traps were checked daily to remove captures and to replace baits. From the captured rats (n=18), four were lost (body parts, tails or legs, were found on traps), therefore only fourteen individuals were weighted and body and tail lengths were measured. This allowed us to identify the rat species. Due to logistic problems, only some of the individual's stomach contents (n=6), were analyzed (Fig. 5). This procedure was qualitatively done describing the type of items found.

Results

Daily rat capture rate was highly variable, showing a mean of 1.8 ± 2.1 (mean ± SD) (range 0-5, n=18). All captured rats showed a tail length (199.29 ± 17mm, mean ± SD, n = 14) bigger than the body length (176.79 ± 19 mm, n=14) and a mean body mass of 172.86 ± 44.80 g. They all showed a dark colour fur, large naked ears covering the eyes when pulled forward, sharp mouth and a naked tail with epidermal rings. All these features agree with *Rattus rattus* species (Linnaeus, 1758) (Global Invasive Species Database, *www.issg.org/database)* (For more details see table 1). In the rats stomach content (n=6) both plant and animal remains were recorded including arthropod shells and gray down feathers.

Figure 4. Setting traps in the field.

Figure 5. Dissecting rats for dietary analyses.

Discussion

Although our survey had a restricted capture effort, and temporal and/or spatial biases in the determination of species occurrence should be considered (McArdle *et al*. 1990), a negative interaction between invasive rodents has been reported on several islands (Atkinson 1986, Yom-Tov *et al*. 1999). However, the reason for this interaction may be attributed to factors such as the time of introduction, island size and elevation, island conservation status, among others (Russell & Clout 2004). Because of this, it is necessary to carry out a larger sampling effort to confirm that *R. rattus* is the only invasive rodent present in Guafo Island. But, for instance, in

Seychelles Islands *R. rattus* and *R. norvegicus* did not occur on the same islands (Hill *et al*. 2003).

According to the Global Invasive Species Database (2009) the black rat, *Rattus rattus*, is included in the 100 of the World's Worst Invasive Alien Species list (*www.issg.org/database*). This species has colonized a large number of islands worldwide, with a significant negative impact on numerous species (eventually leading to bird extinctions). In fact, among the three invasive rat species (*R. rattus, R. norvegicus* and *R. exulans* Peale, 1848), *R. rattus* may be considered the most harmful (Jones *et al.* 2008). *R. rattus* was introduced to central Chile during the 1600's, but the introduction date on the islands and archipelagos of southern Chile is unknown (Jaksic 1998).

The stomach content of the *R. rattus* individuals showed that they are probably consuming chicks but it is necessary to perform stable isotopes analyses (^{13}C and ^{15}N) to confirm this and direct observations to discriminate between direct predation and scavenging (Stapp 2002, Caut *et al.* 2008). However, there are many reports that have confirmed rat's predation and its consequences on insular birds (egg, chicks and adults) (*e.g.* Atkinson 1985, Jouventin *et al*. 2003). *R. rattus* is a general predator that is able to change its diet depending on the resources availability (Caut *et al*. 2008); therefore its presence on Guafo Island implies a potential threat to this seabird and also to other species.

A recent review indicates that rat eradication attempts have been successful, and in the case of black rat eradication have succeeded on 159 islands and failed only on 15 islands (Howald *et al*. 2007), Hermite Island being the largest one with 1022 ha. Guafo Island is one order of magnitude larger than Hermite Island and although an increase in scale could be correlated with an increase in habitat complexity, scale per se has not deterred managers from planning eradication of black rats with an acceptable risk of failure (e.g. Macquarie Island and Tristan da Cunha Island) (Parkes 2008). However basic knowledge of *R. rattus* ecology (e.g. annual intrinsic rate of increase, migration, density fluctuations, breeding season, annual variation in body condition, home range and daily movements) and a full feasibility study (e.g. Parkes 2008) is required to estimate costs, risks and constraints inherent in any attempt to eradicate rats from Guafo Island.

The *P. griseus* colony from Guafo Island is only the third reported in South American waters for this species, and despite of the fact that it is the largest in the world (Reyes-Arriagada *et al*. 2007) it has no formal protection under Chilean laws. Further research is therefore clearly needed for this colony, in order to improve the basic knowledge and also to implement management and conservation measures, including rat eradication. This is likely to be necessary because although the declines of up to 90% of sooty shearwater populations in the California Current were attributed to factors such as fisheries interaction (Veit *et al*. 1996) and global climate change (Veit *et al.* 1997), the presence of rats and other introduced species on this breeding colony could be a factor contributing to the population decline. Finally, to fully understand the population status of *P. griseus* along the eastern Pacific coast (Chile) more research is required and this must be integrated with the knowledge generated in the western Pacific. This will allow the implementation of management plans and conservation measures at a global scale.

References

Atkinson IAE (1985) The spread of commensal species of *Rattus* to oceanic islands and their effect on island avifaunas. Conservation of Island Birds 3:35-81

Atkinson IAE (1986) Rodents on New Zealand's northern offshore islands: distribution, effects and precautions against further spread. *In*: The offshore islands of northern New Zealand (ed. by AE Wright & RE Beever), pp.13-40. N.Z. Department of Lands and Survey, Information Series Nº 16. Wellington, New Zealand

Briggs KT, Chu EW (1986) Sooty shearwaters off California: distribution, abundance and habitat use. Condor 88: 355-364

Brothers NP (1984) Breeding, distribution and status of burrow-nesting petrels at Macquarie Island. Australian Wildlife Research 77:113-131

Caut S, Angulo E, Courchamp F (2008). Dietary shift of an invasive predator: rats, seabird and sea turtles. Journal of Applied Ecology 45:428-437

Clucas RJ, Fletcher DJ, Moller H (2008). Estimates of adult survival rate for three colonies of sooty shearwater (*Puffinus griseus*) in New Zealand. Emu 108:237-250

Cooper J, Underhill LG, Avery G (1991) Primary moult and transequatorial migration of the sooty shearwater. Condor 93:724-730

Dulloo ME, Kell SR, Jones CG (2002) Impact and control of invasive alien species on small islands. International Forest Review 4:277-285

Gaze P (2000) The response of a colony of sooty shearwater (*Puffinus griseus*) and flesh-footed shearwater (*P. carneipes*) to the cessation of harvesting and the eradication of Norway rats (*Rattus norvegicus*). New Zealand Journal of Zoology 27:375-379

Global Invasive Species Database (2009) 100 of the World's Worst Invasive Alien Species. <available on-line> *http://www.issg.org/database/species/ecology.asp?si=19&fr=1&sts=sss*. <Accessed 26th March 2009>

Hamilton SA, Moller H, Robertson CJR (1997) Distribution of Sooty shearwater (*Puffinus griseus*) breeding colonies along the Otago Coast, New Zealand, with indication of countrywide populations trend. Notornis 44:15-25

Harper GA (2007) Detecting predation of a burrow-nesting seabird by two introduced predators, using stable isotopes, dietary analysis and experimental removals. Wildlife Research 34:443-453

Hill MJ, Vel T, Shah NJ (2003) The morphology, distribution and conservation implications of introduced rats, *Rattus spp.* in the granitic Seychelles. African Journal of Ecology 41:179-186

Howald G, Donlan CJ, Galvan JP, Russell JC, Parkes J, Samaniego A, Wang Y, Veitch D, Genovesi P, Pascal M, Saunders A, Tershy B (2007) Invasive Rodent Eradication on Islands. Conservation Biology 21:1258-1268

Imber MJ (1975) Petrels and predators. International Council for Bird Preservation Bulletin12:260-263

IUCN (2009) IUCN Red List of threatened species. <available on-line> *http://www.iucnredlist.org*.

Jaksic FM (1998) Vertebrate invaders and their ecological impacts in Chile. Biodiversity & Conservation 7:1427-1445

Jones C (2000) Sooty Shearwater (*Puffinus griseus*) breeding colonies on mainland South Island, New Zealand. Evidence of decline and predictors of persistence. New Zealand Journal of Zoology 27:327-334

Jones HP, Tershy BR, Zavaleta ES, Croll DA, Keitt BS, Finkelstein ME, Howald GR (2008) Severity of the Effects of Invasive Rats on Seabirds: A Global Review. Conservation Biology 22:16-26

Jouventin P, Bried J, Micol T (2003) Insular bird populations can be saved from rats: a long term experimental study of white-chinned petrels *Procellaria aequinoctialis* on Ile de la Possession (Crozet archipelago). Polar Biology 26:371-378

King CM (ed) (2005) The handbook of New Zealand mammals. Auckland, Oxford University Press. 610 pp

Lyver PO'B, Moller H (1999) Modern technology and customary use of wildlife: the harvest of sooty shearwaters by Rakiura Maori as a case study. Environmental Conservation 26:280-288

Lyver PO'B, Robertson CJR, H Moller (2000) Predation at sooty shearwater (*Puffmus griseus*) colonies on the New Zealand mainland: is there safety in numbers? Pacific Conservation Biology 5:347-357.

McArdle BH, Gaston KJ, Lawton JH (1990) Variation in the size of animal populations: patterns, problems and artefacts. Journal of Animal Ecology 59:439-454

Parkes J (2008) A feasibility study for the eradication of house mice from Gough Island. RSPB Research Report 34

Reyes-Arriagada R, Campos-Ellwanger P, Schlatter RP, Baduini C (2007) Sooty Shearwater (*Puffinus griseus*) on Guafo Island: the largest seabird colony in the world?. Biodiversity and Conservation 16:913-930.

Robertson CJR, Bell BD (1984) Seabird status and conservation in the New Zealand region. In: Croxall JP, Evans PGH, Schreiber RW (eds) Status and conservation of the world's seabirds. Inst Counc for Bird Press. Tech. Pub. No. 2, England, pp 573-586

Russell JC, Clout MN (2004) Modelling the distribution and interaction of introduced rodents on New Zealand offshore islands. Global Ecology and Biogeography 13:497-507

Scofield P, Christie D (2002) Beach patrol records indicate a substantial decline in sooty shearwater (*Puffinus griseus*) numbers. Notornis 49:158–165

Spear LB, Ainley DG (1999) Migration routes of sooty shearwater in the Pacific Ocean. Condor 101:205-218

Stapp P (2002) Stable isotopes reveal evidence of predation by ship rats on seabirds on the Shiant Islands, Scotland. Journal of Applied Ecology 39:831-840

Uhlmann S, Fletcher D, Moller H (2005) Estimating incidental takes of shearwaters in driftnet fisheries: lessons for the conservation of seabirds. Biological Conservation 123:151-163

Veit RR, McGowan JA, Ainely DG, Wahl TR, Pyle P (1997) Apex marine predator decline ninety percent in association with changing oceanic climate. Global Change Biology 3:23-28

Veit RR, Pyle P, McGowan JA (1996) Ocean warming and long-term change in pelagic bird abundance within the California current system. Marine Ecology-Progress Series 139:11-18

Wanless RM, Angel A, Cuthbert R, Hilton GM, Ryan PG (2007) Can predation by invasive mice drive seabird extinction? Biology Letters 3:241-244

Warham J, Wilson GJ (1982) The size of the sooty shearwater population at the Snares islands; New Zealand. Notornis 29:23-30

Yom-Tov Y, Yom-Tov S, Moller H (1999) Competition, coexistence and adaptation among rodent invaders to Pacific and New Zealand islands. Journal of Biogeography 26:947-958

Felipe N. Moreno-Gómez[1,2], Ronnie Reyes-Arriagada[2] & Roberto P. Schlatter[2]
[1]Instituto de Ecología y Evolución, [2]Instituto de Zoología, Universidad Austral de Chile, Casilla 567, Valdivia, Chile.
E-mail: *felipe.moreno@postgrado.uach.cl*

Table 1. Diagnoses of the principal invasive rat species. For the Guafo Island specimens mean ± SD is given (n = 14). Modified from King 2005.

Species	***R. rattus***	***R. norvegicus***	***R. exulans***	**Checked for Guafo specimens**
Adult weight	120-160 up to 225 g	200-300 up to 450 g	60-80 up to 180 g	172.86 ± 44.80 g
Tail length	Much longer than head-body length	Clearly shorter than head-body length	Slightly shorter or longer than head-body length	199.29 ± 17.00 mm
Maximum head-body length	225 mm	250 mm	180 mm	176.79 ± 19.00 mm
Ears	19-26 mm ; cover eyes when pulled forward	14-22 mm ; do not cover eyes when pulled forward	15.50-20.50 mm; cover eyes when pulled forward	Not measured, but cover eyes when pulled forward
Adult hind foot length	28-38 mm	30-41.50 mm	24.5-31 mm	Not noted
Fur on back	Grey-brown or black	Brown	Brown	Dark
Number of nipples	10-12, usually 10	12	8	Not noted

Eradication of invasive Mynas from islands. Is it possible?

Susana Saavedra

*Introduced and breeding populations of common Mynas (*Acridotheres tristis*) have been managed on six different islands in the past ten years (1999/2009) by the author. Permanent surveillance and the set up of a Quick Response Team (QRT) have lead eradications or control of those populations.*
The QRT has stopped the myna invasion in Tenerife, Gran Canaria and Mallorca, eradicating their wild breeding populations at its beginning when the number was low and before populations grew and spread within the territory or other islands, and with an excellent cost efficient budget.
Control efforts, the first campaign in Fuerteventura were really successful, covering 80% of the small bird island population. In St Helena, with around 9.000 mynas, this ratio was lower, reaching 4%; and in Ascension Island, the 56% of the myna population was controlled and removed from the environment by trapping.

Introduction

From the ten known species of *Acridotheres*, only the common myna (*Acridotheres tristis* Linnaeus, 1766) has been catalogued by the IUCN List of the 100 Worst Invasive Species worldwide (Lowe et al. 2000).

The common myna is a very intelligent bird and highly adaptable to the environment where it gets installed. It's omnivorous diet ranges from eggs to chicks of terrestrial and marine local birds (Huges 2008), insects, reptiles, nectar, seeds of invasive plants and even rests of marine food, which allows it to find food on human waste, crops or areas with cattle or domestic animals. Mynas are excellent human commensals. Their instinct of breeding in holes force them to compete directly with native local bird species that use this niche and which get displaced (Pell and Tidemann 1997), defend aggressively their territory, food and water sources. Common mynas are very noisy, especially when they wake up at sunrise and when they congregate to sleep in the roost sites in the evenings. Myna species are able to spread parasites and diseases between birds (Orueta 2002) and to other vertebrate species [H5N1 (Darrell et al. 2007)] including humans [*Salmonella* (Allan 2009), *Ornithonyssus bursa* (Manpreet et al. 2009) *and Exophiala dermatitidis* (genotype B) (Sudhadham et al. 2008)].

These calamities occur in a very dangerous form when common mynas invade insular environments. Oceanic islands are known to be even more delicate, as it is known that they house numerous endemism which represent a great ecological fragility associated both with its reduced territory and the simplicity of its biological aboriginal communities. Therefore, the priority target in conservation for insular environments is eradication or control of exotic invasive species, though it might not be voluntarily assumed by local authorities. The control or eradication efforts which took place in Seychelles – eradication project in Cousin Island (Millett et al. 2005) and in Ascension, where 40 mynas where not a target specie during a cat eradication campaign in 2004 (Hughes et al. 2008), have not been conclusive. Obviously it is a complicated challenge so much that, its viability has been questioned.

In this contribution six projects are shown where the author has worked with this specie (1999-2009), having achieved its eradication in some islands, and control in some others. From the experience gained it stands out some practical aspects and recommendations that could be useful to other people who must fight this dangerous specie.

The six islands cases

The eradication and control campaigns have been done in six islands, most of them with a volcanic origin and in the Atlantic Ocean (except the island of Mallorca, with a continental origin, in the Mediterranean Sea). Table I resumes interesting data from these territories.

Table I. Islands where Common mynas have been eradicated or controlled

	Tenerife	Gran Canaria	Mallorca	Fuerteventura	St Helena	Ascension
Geographic location	N. Atl. Ocean	N. Atl. Ocean	Mediterranean Sea	N. Atl. Ocean	S. Atl. Ocean	S. Atl. Ocean
Surface in km2	2.034	1.560	208	1.659	121	91
Human population	899.833	838.397	846.210	103.167	5.157	1.122
Year of project	1999/2000	2006	2006	2008	2009	2009
Achieved goal	Eradication	Eradication	Eradication	Control	Control	Control
Promoting body	Island Council	Island Council	Balearic Government	Live Arico	RSPB	Live Arico

Projects have been undertaken on behalf of different Authorities or under Live Arico's initiative. Live Arico is a non governmental organisation, related with environment and animal protection and located in Tenerife. In 2004, it offered me the possibility to establish a tiny Invasive Species Department, a starting point for future eradication or control campaigns. As time passed by, a Quick Response Team (QRT) arose, and it is this QRT which establishes and executes the appropriate combination of activities and provides the practical response over control and/or eradication of the invasive specie on the field.

Mallorca has been the only island to have two campaigns; the first one, done by the Live Arco QRT, was a myna control and local staff training effort. The second one, six months later, undertaken by the local Conservation Authority Staff achieved eradication. (C. Álvarez and X. Manzano, pers. com.).

Saint Helen's Project was paid with EU founds, auspiced by the Royal Society for Protection of Birds. The Project leader was Prof. C. Feare (Feare and Saavedra 2009).

Working strategy

The working strategy has been improved throughout the years and it consists basically in the following steps:

1) Previous evaluation of the situation

Internet is the first source to find new quotes on common mynas in islands and other territories. Once the presence of *Acridotheres tristis* free in that environment is confirmed, the QRT gathers all the information needed to plan a quick evaluation of the situation and be able to develop a Project to control or eradicate the myna population, depending on their numbers, their pathway and the recourses available in situ.

2) Proceedings proposal

If QRT deals with a population lower than 50 individuals, the goal of the project is eradication. If the population is around 1.000 birds, its objective is control, but always having in mind the target to achieve eradication, if funds and resources are available. For bigger populations, see Conclusion nº 3. The campaign with the proceedings proposed by the QRT is forwarded to the relevant conservation authorities with a budget requesting funds; all permits and authorisations are obtained at the same time.

3) Design in situ

In order to design an adequate trapping procedure, mynas are carefully studied within their boundaries as well as in their sources of food and drink, roosting and nesting sites, as well as possible entry pathways, and last but not least, their relation with other birds, humans and substructures. The election of poison or trapping methods must be flexible. It is very important to obtain the consent of the local societies for the protection to animals on how the birds will be handled. This is the moment to train local personnel, should there be any. As it is legal to import *Acridotheres* brought up in EU, to any of the islands of the Spanish territory, there is always a possibility to find free mynas after control or eradication campaigns. Therefore, it is very important to leave local personnel trained "in situ", so that they can act quickly upon possible fugitives.

4) Citizen awareness.

It is also important to contact local institutions where one will work (local government, police, NGOs, pet shops etc.) in order to inform them of the project and let them sink in the message that the foreseen intervention is for the protection of local biodiversity through control of exotic invasive species. This message, well presented, helps a lot with the work to be done. In order to reach general public one has to use communication media or distribute small one-page leaflets in bars, vets, neighbour associations and amongst workers of parks and gardens, etc.

5) Operational procedures

Trapping, shooting or poisoning of mynas starts. It is very important in this phase, to work with great discretion. One has to put traps, if possible, out of the eyesight of people. Furthermore, traps should be baited and emptied while there is still light, only if the operator is able to get out of the free mynas' view. Otherwise mynas will get trap shy.

6) Final report

This report makes a resume on all activities undertaken and the final results. In cases of confirmed eradication, it includes recommendations to avoid the entry of new mynas into the island as well as a basic alert system. If there remains a great deal of free birds, or it is a long term control, this report includes a procedure for the next stages and their follow-up. Any other type of recommendation which is considered as convenient will also be included.

Table II. Details of campaigns and methods applied in each island

Working strategy	Tenerife	Gran Canaria	Mallorca	Fuerteventura	St Helena	Ascension
First seen	1994	2006	1998	2006	1880's	1879/1882
Pathway	Pet shops	Pet shops	Pet shops	Zoological garden	Intentional introduction	Intentional introduction
Date and duration of the work	1999/2000 5 months	2006 10 days	2006 30 days	2008 10 days	2009 30 days	2009 53 days
Eradication / Control	Eradication	Eradication	Eradication	Control	Control	Control
Trapping days	60	9	27	9	28	53
System type	Mechanical	Mechanical	Mechanical	Mechanical	Mechanical & chemical	Mechanical
Methods	Trap & air pistol	Trap	Trap	Trap	Traps & Avicide	Traps
Decoys	Yes	Yes	Yes	Yes	Yes	No (*)
Bait	No	Yes	Yes	Yes	Yes	Yes
Citizen awareness	Yes	No	Yes	Yes	Yes	Yes
Training local staff	No	Yes	Yes	No	Yes	No
Number of campaigns	1	1	2	1	1	1

(*) Decoys used only one day.

Methods

Shooting. - Few have been the occasions where an air gun or an air rifle (Gamo brand) with calibre 4.5 bullets was used, mostly for shooting isolated mynas which were avoiding or did not justify the use of traps. These air guns require a local license, and it is better to use them out of the general public view.

Traps - Different types of traps that have been used in capturing mynas.

- SRT - Small Round decoy Trap. Commercially made in Belgium 50 cm size with a central space for the decoy and 4 catching compartments around provided with a door release system activated by the caught bird. Is able to trap more than one myna per compartment. Weight: 5,2 Kg.

- SDT - Small Decoy Trap. A hand made square or round trap, 70 cm size, with a central decoy compartment and 4 catching compartments dependent upon individuals tripping a door release for closing, each capable of catching one (or more) myna per compartment. Weight: 6 Kg.

- LDT - Large Decoy hand made square Trap, 1.2 m sides, with a central decoy compartment and 12 catching compartments, each capable of catching between one and three mynas on each compartment. Weight: between 7 and 9 Kg.

• FT - Funnel Trap. A rectangular hand made trap with a 50 x 40 x 40 cm high catching area with 2 entrance funnels, each fitted with bob wire to prevent escape through the funnels. This trap also has a holding compartment 40 x 40 x 70 cm high, which the birds access by another horizontal funnel. This trap can catch numerous mynas. Weight: around 4 or 5 Kg.

Figure 1: FT St Helena

• MMT - Myna Magnet Trap. Commercially made in Australia. 1.8m (h) x 0.7m (w) x 0.7m (l); they are two chamber collapsible traps, with perches, drinker, feeder, one-way doors and a gassing kit. Weight: 10.5 Kg.

Traps can be activated with or without bait and decoys (see Table II). Decoys are especially required when trapping small populations or a few targeted individuals in bigger settlements, as they act as a very powerful attraction for the free mynas. The decoys used are kept in captivity by the QRT, trapped by hand in their nests or selected from the first caught birds. Keeping decoys supposes an investment in time and money spent in handling, feeding, cleaning, enrichment and veterinary services.

The bait used (see Table III) have been fruits (e.g. papaya, banana, apple), white sliced bread or boiled rice, or alive larvae from *Tenebrio molitor*, in which case a mobile breeding station must be organised for field work.

Table III. Baits used by islands

Baits	Tenerife	Gran Canaria	Mallorca	Fuerteventura	St Helena	Ascension
Tenebrio molitor	No	Yes	Yes	Yes	No	No
Carica papaya	No	Yes	Yes	Yes	No	No
Musa paradisiaca ssp.	No	Yes	Yes	No	No	Yes
Malus domestica	No	Yes	Yes	No	No	No
Oryza sativa ssp.	No	No	No	No	Yes	No
Dry cat food	No	No	Yes	Yes	No	No
Bread	No	No	No	No	Yes	Yes

Trapped mynas are sacrificed by placing them individually in a holding bag (pillowcase) and hitting the entire body hard against a concrete floor. This technique is regarded as one of the most rapid and humane methods, amongst others, and approved by the Royal Society for Preventing Cruelty to Animals (RSPC) teams in the south Hemisphere and by Live Arico in the North Hemisphere.

Poisoning. - It is chosen to use avicide in areas where birds concentrate and when consensus is gained with all the social sectors implicated, and after a detailed risk analysis evaluating dangers for humans, wild and domestic animals and ecosystems. The bait is chosen and the avicide (Starlicide™, DRC-1339) is applied. This compound metabolises very quickly and does not transcend to the trophic chain. Results are estimated by collecting carcasses and by counting birds arriving to the roost sites after the treatment, of which a

census had been previously made. The only occasion where I have used poison was in St. Helena, under Professor's C. Feare leadership.

Results

Traps and their captures are reflected in Table IV.

Table IV. Birds per trap type and island.

	Tenerife	Gran Canaria	Mallorca	Fuerteventura	St Helena	Ascension	Total per traps
SRT (same trap)	9	2	12	20	-	-	43
SDT (one trap per island)	-	-	-	-	161	53	214
LDT (one trap)	-	-	-	-	78	-	78
FT (one trap per island)	-	-	-	-	42	222	264
MMT(two traps in one island)	-	-	-	-	-	345	345
By hand	1	1	1	1	1	3	8
Total birds per islands	10	3	13	21	282(*)	623	952

Data regarding birds of the six campaigns and by islands can be found in Table V. All common myna population lower than 50 individuals have been eradicated from the environment (Tenerife, Gran Canaria y Mallorca) except in Fuerteventura, where some few birds remained free and it will necessary to do a new control campaign (in preparation).

Table V. Bird census, before and after campaigns, up to December 2009.

Birds by island	Tenerife	Gran Canaria	Mallorca	Fuerteventura	St Helena	Ascension
Estimated at beginning	12	3	12	30	8.000-10.000	1.100
Captured during campaign	10	3	10	24	351	623
Free birds after campaign	2	0	7	4	8.000-10.000	477
Free birds in December 2009	(*)	0	0	>4	8.000-10.000	>477

(*) In Tenerife, information on myna sights after the first campaign has been very vague on whereabouts in order to make a follow-up. The QRT has not seen nor caught any free myna in Tenerife since 2000 up to date. There have been notes on sights in various local ornithological yearly reports which have not been able to be confirmed.

In islands with a population superior to 1.000 individuals – Santa Helena and Ascension – these were reduced by 4% and 56, 5% respectively. This difference depends entirely on the estimated quantity of birds present in each island. In Santa Helena the proposed population calculated by Prof. Feare was between 8.000 and 10.000 birds, and in Ascension it was estimated in around 1.100 mynas.

Coverage per island (*Fig. 1*) indicates the control on individuals amongst the population. If catches of

birds are in the segment between 83, 3% and 100% one achieves the eradication aim for a short or medium term. If coverage is less than 80%, another campaign will be necessary in the future.

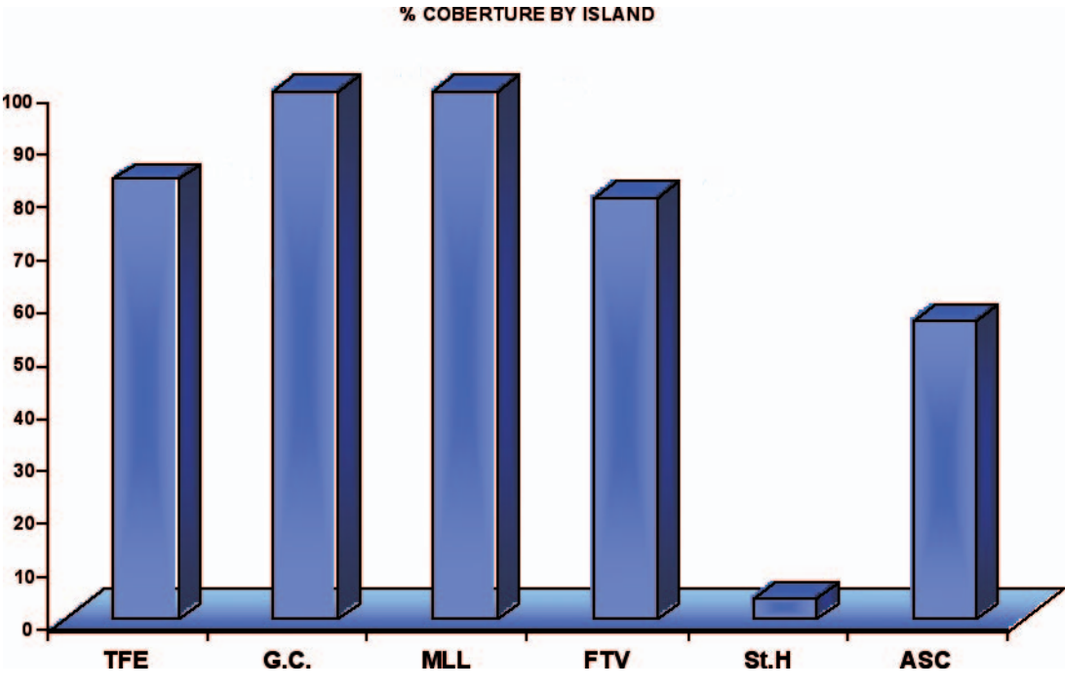


Figure 1.

Recommendations

1. Prevention of operator working risks and emotional overwhelming. Operators need to be wary of the potential of injury when handling traps and birds; therefore persons involved in traps and myna handling must be protected by tetanus immunisation to prevent infection of scratches produced by wire o birds. Wildlife biologists, pest managers, and wildlife health professionals are often responsible for euthanatizing animals that are in excessive number, or that threaten biodiversity or human safety. People who must deal with these animals, especially under public pressure to save the animals rather than destroy them, can experience extreme distress and anxiety (AVMA 2007).

2. Handling and welfare protocols for captive birds. When handling stressed animals unaccustomed to human contact, calming may be accomplished by minimizing visual, auditory, and tactile stimulation. Conditions found in the field, although more challenging than those that are controlled, do not in any way reduce or minimize the ethical obligation of the responsible individual to reduce pain and distress to the greatest extent possible during the taking of an animal's life (see Indian Myna Control Project; Indian Myna Handbook. Available on line at: *http://indianmyna.org//index.php?option=com_content&task=view&id=50&Itemid=108*).

3. Avoiding non target species. The bait should be selected specifically to avoid attracting native or local species from the near area. Remove the baits rest in the evenings and put it fresh again the next mornings. Cover the traps that stay in the environment during the night with a system to avoid trapping any non target specie. Leave some fresh water in the trap, just in case any animal gets inevitable trapped during the night.

Conclusions

1. Eradication of myna populations from islands is possible and cost-efficient (1-2 campaigns) when populations are small (< 50 exx)

2. The use of decoy or funnel traps is the most effective mean of catching mynas in a variety of islands habitats independent from the breeding season. It can lead to a relevant reduction in numbers of mynas and it is a suitable method for control programs.

3. In long term control programs on islands, a combination of different methods such as trapping, poisoning and shooting will be needed. A coordination protocol must be in place to avoid disturbances between methods (Saavedra 2009). The involvement

of local trained personnel is highly recommended in such cases.

4. The main pathway into the Spanish Islands is the escapee or release of animals from a neglected captivity (see Aves exóticas invasoras en España. Propuesta inicial de lista para el catálogo nacional de EEI. Autores: GAE SEO/BirdLife, available online at : http://sites.google.com/site/plataformacatalogoespanoldeeei/documents). The Spanish legislation must stop the legal importation of *Acridotheres species* from within Europe, and it needs to prohibit having mynas as pets or for public or private exhibition, breeding or selling, as they are birds with a very high proved invasiveness, especially on islands.

5. Any initiative regarding eradication or control must have funds and resources enough to cover, over the time scheduled, all the Project phases.

Acknowledgments

It is impossible to name all the people worldwide who have helped, in a way or in another, the QRT during these past ten years. The list would be endless, the general public, ecologists, scientist, ornithologists and government's staff; family and friends… Important Administrations or Institutions have been the International Union for Conservation of the Nature/Invasive Species Specialist Group, Live Arico, Canary Islands administrations, Balearic Government, Royal Society for Protection of Birds, South Atlantic Invasive Species Programme and the Ascension Island Government. I have a great gratitude debt to all of them. I would like to thank all and every one for the help I have received.

References

Allan J (2009) Options for control and eradication of Mynas (*Acridotheres tristis*) on Ascension Island. Head, Wildlife Management Programme Food and Environment Research Agency. Sand Hutton York. (In preparation)

AVMA (2007) Guidelines on Euthanasia, June 2007 (Formerly the Report of the AVMA Panel on Euthanasia). On line: http://www.avma.org/issues/animal_welfare/euthanasia.pdf

Darrell Whitworth, Scott Newman, Taej Mundkur (2007) Wild birds and avian influenza: an introduction to applied field research. For Food and Agriculture Organization of the United Nations. On line: http://www.fao.org/docrep/010/a1521e/a1521e00.HTM

Feare C, Saavedra S (2009) Development of a strategy for control of Common mynas (*Acridotheres tristis)* on St. Helena. Unpublished report to the RSPB and South Atlantic Invasive Species Project

Huges J (2008) Myna matters. Sooty Terns eggs predated by Common Mynas in Ascension Island. The Sea Bird Group. Newsletter 108. June 2008

Hughes J, Martin R, Reynolds J (2008) Cats and seabirds: Effects of feral domestic Cat *Felis silvestris catus* eradication on the population of Sooty Terns *Onychoprion fuscata* on Ascension Island, South Atlantic. *Ibis* 150 (Suppl.1):121–129

Lowe S. J., M. Browne, S. Boudjelas, M De Poorter (2000) 100 of the World's Worst Invasive Alien Species. Published by the IUCN/SSC Invasive Species Specialist Group (ISSG), Auckland, New Zealand http://www.issg.org/database/species/reference_files/100English.pdf

Manpreet K Dhami, Nagle B. (2009) Review of the Biology and Ecology of the Common Myna (*Acridotheres tristis*) and some implications for management of this invasive species. Pacific Invasives Initiative. On line: http://www.issg.org/cii/Electronic%20references/pii/Myna_review_final.pdf

Orueta JE (2002) Manual práctico para el manejo de vertebrados invasores en islas de España y Portugal. Proyecto LIFE 2002NAT/CPIE/000014. Madrid: Gestión de Estudios de Espacios Naturales S.L. Pag 79

Pell AS, Tidemann CR (1997) The impact of two exotic hollow-nesting birds on two native parrots in savannah and woodland in eastern Australia. Biological Conservation 79:145-153

Millett J, Climo G, Shah NJ (2005) Eradication of Common Mynah *Acridotheres tristis* populations in the granitic Seychelles: Successes, failures and lessons learned. *Adv Vertebr Pest Manage 3*:169-183

Saavedra S (2009) First control campaign on mynas (*Acridotheres tristis*) on Ascension Island 2009. Unpublished report to Live Arico.

Sudhadham M, Prakitsin S, Sivichai S, Chaiyarat R, Dorrestein GM, Menken SBJ, de Hoog GS. (2008) The neurotropic black yeast *Exophiala dermatitidis* has a possible origin in the tropical rain forest. Stud Mycol 61: 145-155.

Susana Saavedra
Coordinator, Live Arico - Departamento de Especie Invasoras/Invasive Species Department
Tel: +34 922 641 495 // + 34 620 126 525
e-mail: odisea64@hotmail.com

“Field IT for East Africa”: training young African scientists in Lake Naivasha (Kenya)

David M. Harper, J. Robert Britton, Kenneth M. Mavuti, Nic Pacini, Elena Tricarico & Francesca Gherardi

Lake Naivasha: gem of the Rift Valley

Lake Naivasha (0°45’S, 36°20’E; altitude 1890 m, depth 3-6 m) is the second largest lake in Kenya after Lake Victoria. It lies on the floor of Africa’s Eastern Rift Valley, 80 km North-West from Nairobi, and together with Lake Baringo, constitutes a precious and vital freshwater resource within the Eastern Rift. The natural fluctuation in its water level has been in excess of 12 metres over the last 100 years, as the result of long-term wet and dry climatic cycles superimposed to annual variations of rainfalls (Becht & Harper 2002).

Since the 1980s, industries of national importance have mushroomed around the lake (geothermal power plant, intensive horticulture) opening employment opportunities that have attracted tens of thousands of Kenyans from all over the country. This high immigration rate has inevitably produced a degradation of lakeshore habitats due to: unplanned settlements, illegal fishing, narrowing of the papyrus belt, and livestock overgrazing (Becht et al. 2006) (Figure 1). The proliferation of small scale agriculture throughout the basin has led to the cultivation of river banks with increased erosion and lake sedimentation (Harper & Mavuti 2004). At the same time, massive water abstraction for agricultural production and for industrial purposes lowered the lake level by about a third from its expected value, thus increasing the proportion of shallow littoral areas to open water (Becht & Harper 2002) (Figure 2).

Figure 1. The current state of Lake Naivasha, devoid of native aquatic plants because of crayfish, turbid water because of crayfish and carp stirring up the sediment and with water hyacinth the dominant floating plant on the lake side of papyrus. Photo: Francesca Gherardi

Despite this, Lake Naivasha undoubtedly retains a remarkable scenic beauty, surrounded by mountains and offering magnificent views of the nearby volcanoes. Its waters support a rich ecosystem filled with frolicking hippopotamus, riparian grasslands where waterbuck, giraffe, zebra and various antelopes graze, dense patches of riparian acacias inhabited by African fish eagle, buffalo and bushbuck, extensive swampy areas where waterfowl rest and feed. With its four waterbodies with different degrees of salinity, interspersed by a variety of riparian and dryland forest (Crescent Island, Oloidien, Sonachi, and the Main Lake), the basin constitutes an ornithologists' paradise: a determined 'twitcher' can easily build up a hundred species in a few hours. Lake Naivasha has long been a tourist destination: about 40,000 tourists visited the lake and its surroundings in 1998 (Becht et al. 2006), including visits made *en route* to major destinations such as the Maasai Mara National Reserve or the Lake Nakuru National Park.

Figure 2. A view of Lake Naivasha in September 2009. Photo: Francesca Gherardi

Lake Naivasha's ecological value was internationally recognized in 1995, when it was declared as the Kenya's second Ramsar site, after Lake Nakuru (Ramsar 2009a). Today, the visual tranquillity and beauty offered by the lake are only apparent: its ecological status has become so serious during later years as to place Naivasha on the Montreux record of threatened Ramsar sites (Ramsar 2009b).

Alien species' domination of the lake's ecosystem

Deliberate and accidental introductions of alien species represent a major driver of ecological change in Lake Naivasha: their multiple impacts, acting in concert with physical degradation, cause increasing concern about its future ecological status.

Figure 3. A participant to the Naivasha field camp in September 2009 showing a trap with some individuals of *Procambarus clarkii* captured from Gilgil River. Photo: Francesca Gherardi

The fish community is entirely alien. Because the lake dried up completely during the Makalian and Nakurian post-pluvial (Leakwy 1931), the number of endemic fishes was seemingly reduced to the single *Aplocheilichthys antinorii* (small-toothed carp). This species, last recorded in 1962, was likely driven to extinction by *Micropterus salmoides* (largemouth bass), the first species to be deliberately introduced in 1929. A commercial fishery started in 1963, based on *M. salmoides* and two tilapias (*Oreochromis leucostictus* and *Tilapia zillii*), which had survived following a number of re-introductions through the 1950s (Muchiri et al. 1995). Fishes are exported to Nairobi and Nakuru as well as consumed locally. Since the 1980s, however, over-fishing and water level fluctuations have both led to a sharp decrease in landings (Muchiri & Hickley 1991). Today, the fish community is dominated by common carp (*Cyprinus carpio*), accidentally introduced in 1999 (Britton et al. 2007).

The red swamp crayfish *Procambarus clarkii* was deliberately introduced in 1970 as a food source for the bass (Foster & Harper 2007) and ended up supporting a lucrative export activity targeting European markets with an annual load of several hundred metric tons. However, since 1983, annual catches reduced to 40 metric tons, mainly offered to international tourists visiting the lakeshore lodges (Harper et al. 1990). The ecological impact of *P. clarkii* was dramatic: it led to the total elimination of the floating-leaved lilies and submerged macrophytes and to the decline of many macroinvertebrate groups including molluscs, leeches, caddisflies and mayflies (Clark et al. 1989). In the late 1980s, the disappearance of the habitat refuge provided to *P. clarkii* by lake macrophytes induced in-

tensified predation by *M. salmoides* and thus a temporary crash in the density of the crayfish population (Hickley et al. 1994; Hickley & Harper 2002).

A cycle of plant recovery due to the *P. clarkii* decline, followed by a build-up of crayfish densities and then by new plant decline, seemed to have established by the early 1990s (Harper 1992). By the mid 1990s, however, water hyacinth *Eichhornia crassipes*, another alien first appeared in 1988, had produced dense littoral and floating mats that offered a permanent refuge for *P. clarkii.* This protection from predation allowed high recruitment in the crayfish population (Harper et al. 2002; Smart et al. 2002; Ngari et al. 2009) until November 2000, when an unexpected decline was again recorded. This new crash was seemingly caused by the break-up of *E. crassipes* mats due to the hyacinth weevil, *Cyrtobagus eichhorniae*, introduced to control water hyacinth by the Kenya Agricultural Research Institute (KARI) first in 1996 and again in 1999. During the last decade, submerged macrophytes and *P. clarkii,* as well as *E. crassipes* and *C. eichhorniae* populations, were subject to unstable oscillations as a consequence of the domination of the omnivorous *C. carpio* (Britton et al. 2007). Finally, in 1999 *P. clarkii* appeared in the two perennial lake tributaries, the Malewa and the Gilgil, where it is currently spreading (Figure 3); its first arrival being possibly due to either natural upstream movements and/or human introduction to control leeches (Foster & Harper 2006). In the rivers, *P. clarkii* poses threat to the indigenous river crab *Potamonautes loveni* (Foster & Harper 2006) and replaces crabs as the primary food item for the African clawless otter, *Aonyx capensis* (Ogada et al. 2009).

Alien species now dominate each main level of the lake's foodweb; in this respect Lake Naivasha is one of the best studied examples of an alien-driven ecosystem. The main primary producer in the littoral is *E. crassipes* together with *Salvinia molesta*, first recorded in the lake in 1961 (Hubble & Harper 2000). The red swamp crayfish is a voracious omnivore, with a diet including terrestrial plants from the lake edge, detritus, and benthic invertebrates (Harper et al. 2002). The carp is a bottom-grubber (Britton et al. 2007), acting both as a competitor and as a predator of *P .clarkii*. Only at the top of the foodweb are indigenous predators, birds such as cormorants, fish eagles, grebes, and ibises.
The combination of the impacts caused by alien species, physical degradation of riparian habitats, and decrease in water level induced a switch from moderately to highly eutrophic conditions. The 1990s phytoplankton community, strongly dominated by a persistent population of the diatom *Aulacoseira italica*, was replaced from 2005 onwards by frequent blooms of the cyanobacterium *Microcystis* sp. (Harper et al. 2006).

Figure 4. Some participants to the Naivasha field camp in September 2009. Photo: Francesca Gherardi

The project

Since the beginning of the 20th century, the biodiversity and the ecology of Lake Naivasha have been abundantly studied by Kenyan and British scientists. During the last 25 years, the lake has been the focus of numerous researches coordinated by a Leicester University led Earthwatch team. The lake has also been the object of studies conducted by Dutch scientists from the International Institute for Geo-Information Science and Earth Observation (ITC), as well as by many Kenyan scientists from local and overseas universities, the Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Wildlife Services (KWS), and KARI. In 2008, the British Council financed the project "Field IT for East Africa" under its DelPHE scheme for enhancing higher education, with the principal aim of training young East African scientists in ecology and conservation through research camps in Lake Naivasha and in Lake Natron (Tanzania). Ten institutions are partners of the project: University of Nairobi (Kenya), Sokoine University of Agriculture (Tanzania), University of Leicester and Bournemouth University (UK), University of Dublin (Ireland), University of Florence, University of Insubria and University of Calabria (Italy), ITC (The Netherlands), and the European Regional Centre for Ecology, UNESCO (Poland) (Figure 4). The biology of invasive species and the different implications of biological invasions also in terms of human economy and health have been one of the several specific objectives of the project. Lake Naivasha with its complex history of invasions is no doubt an optimal theatre stage where awareness of the problem of invasive species can be raised and scientific competencies can be built.

References

Becht R, Harper DM (2002) Towards an understanding of human impact upon the hydrology of Lake Naivasha. Hydrobiologia 488:1–11

Becht R, Odada EO, Higgins S (2006) Lake Naivasha. Experiences and lessons learned. International Lake Environment Committee Lake Basin Management Initiative, pp 277–298. *http://www.worldlakes.org/uploads/17_Lake_Naivasha_27February2006.pdf*

Britton JR, Boar R, Grey J, Foster J, Lugonzo J, Harper DM (2007) From introduction to fishery dominance: the initial impacts of the invasive carp *Cyprinus carpio* in Lake Naivasha, Kenya, 1999-2006. Journal of Fish Biology 71:239–257

Clark F, Beeby A, Kirby P (1989) A study of the macroinvertebrates of lakes Naivasha, Oloidien and Sonachi, Kenya. Revue Hydrobiologie Tropicale 22:21–33

Foster J, Harper D (2006) Status of the alien Louisianan red swamp crayfish *Procambarus clarkii* Girard and the native African freshwater crab *Potamonautes loveni* in rivers of the Lake Naivasha catchment, Kenya. Freshwater Crayfish 15:189–194

Foster J, Harper D (2007) Status and ecosystem interactions of the invasive Louisianan red swamp crayfish *Procambarus clarkii* in East Africa. In: Gherardi F. (ed.) Biological invaders in inland waters: Profiles, distribution, and threats Springer. Dordrecht, pp 91–101

Harper DM (1992) The ecological relationships of aquatic plants at Lake Naivasha, Kenya. Hydrobiologia 232:65–71

Harper DM, Muchane M, Kimani DK, Mwinami T (2006) Thousands of lesser flamingos at Lake Naivasha? Scopus 26:8–10

Harper D, Mavuti K (2004) Lake Naivasha, Kenya: Ecohydrology to guide the management of a tropical protected area. Ecohydrology and Hydrobiology 4:287–305

Harper DM, Mavuti KM, Muchiri SM (1990) Ecology and management of Lake Naivasha, Kenya, in relation to climatic change, alien species introductions and agricultural development. Environmental Conservation 17:328–335

Harper D, Smart AC, Coley S, Schmitz S, North R, Adams C, Obade P, Mbogo K (2002) Distribution and abundance of the Louisiana red swamp crayfish *Procambarus clarkii* Girard at Lake Naivasha, Kenya between 1987 and 1999. Hydrobiologia 488:57–71

Hickley P, Harper DM (2002) Fish community and habitat changes in the artificially stocked fishery of Lake Naivasha, Kenya. In: Cowx IG (ed.) Management and ecology of lake and reservoir fisheries. Fishing News Books, Blackwell Scientific Publications. Oxford, pp 242–254

Hickley P, North E, Muchiri SM, Harper DM (1994) The diet of largemouth bass, *Micropterus salmoides*, in Lake Naivasha, Kenya. Journal of Fish Biology 44:607–619

Hubble DS, Harper DM (2000) Control of primary production in a tropical shallow lake. Verhandlungen Internationale Vereinigung Limnologie 27:920–923

Leakey LSB (1931) East African lakes. Geographical Journal 77:497–514

Muchiri SM, Hart JB, Harper DM (1995) The persistence of two introduced species in Lake Naivasha, Kenya, in the face of environmental variability and fishing pressure. In: Pitcher TJ, Hart JB (eds) Impact of species change in African lakes. Chapman & Hall. London, pp 299–319

Muchiri SM, Hickley P (1991) The fishery of Lake Naivasha, Kenya. In: Cowx IG (ed) Catch effort sampling strategies: Their application in freshwater fisheries management. Fishing News Books, Blackwell Scientific Publications. Oxford, pp 382–392

Ngari N, Kinyamario JI, Ntiba MJ, Mavuti KM (2009) Factors affecting abundance and distribution of submerged and floating macrophytes in Lake Naivasha, Kenya. African Journal of Ecology 47:32–39

Ogada MO, Aloo PA, Muruthi PM (2009) The African clawless otter *Aonyx capensis* (Schinz, 1821) and its diet as an indicator of crayfish invasion dynamics in aquatic systems. African Journal of Ecology 47:119–120

Ramsar (2009a) About the Convention on Wetlands ?(Ramsar, Iran, 1971), *http://www.ramsar.org/index_about_ramsar.htm*. Consulted 02/08/2009

Ramsar (2009b) The Montreux Record. *http://www.ramsar.org/key_montreux_record.htm*, Consulted 02/08/2009

Smart AC, Harper DM, Malaisse F, Schmitz S, Coley S, Gouder de Beauregard A-C (2002) Feeding of the exotic Louisiana red swamp crayfish, *Procambarus clarkii* (Crustacea, Decapoda), in an African tropical lake: Lake Naivasha, Kenya. Hydrobiologia 488:129–142

David M Harper
Department of Biology, University of Leicester, University Road, Leicester, LE1 7RH, UK

J Robert Britton
School of Conservation Sciences, Bournemouth University, Poole, Dorset, BH12 5BB, UK

Kenneth M Mavuti
School of Biological Sciences, University of Nairobi, Nairobi, Kenya

Nic Pacini
Dipartimento di Ecologia, Università degli Studi della Calabria, 87030 Arcavacata di Rende, Italy

Elena Tricarico and Francesca Gherardi
Dipartimento di Biologia Evoluzionistica "Leo Pardi", Università degli Studi di Firenze, 50125 Firenze, Italy

“Beaufort Scale” for bioinvasion impacts

Sergej Olenin & Aleksas Narščius

Why a standardized bioinvasion impact assessment system?

More than two hundred years ago Sir Francis Beaufort, a British admiral and hydrographer, introduced a scale of sea state to oblige his naval officers reporting weather observations in a standardized way. It seems that bioinvasion science and management needs something similar in order to reduce subjectivism in assessment and reporting the impacts caused by Invasive Alien Species (IAS). So far such assessments have been based on expert judgment. Even in the listings of worst invaders their impacts often are being reported without indication on how severe the impact is.

On another side, a standardized description and evaluation of impacts is needed for many applications, e.g. for compilation of “black” lists of target IAS and comparative account of their harmful effects; prioritization of management options, which involve species that can be practically managed in some way; for compassion of the same IAS in different ecosystems; and even for overall environmental status assessments taking into account the bioinvasion effects in particular territories or water bodies.

Theory: a biopollution level index

The approach to estimate the magnitude of bioinvasion impacts or “Biopollution level” (BPL) index was developed by a team of researchers within two recent EU funded projects, ALARM and DAISIE (Olenin et al., 2007). Biological pollution is defined as the impact of alien species on ecological quality and includes (but is not confined to) the genetic alteration within populations, the deterioration or modification of habitats, the spreading of pathogens and parasites, competition with and replacement of native species, etc.
The BPL method takes into account the abundance and distribution range (ADR) of alien species in relation to native biota and aggregates data on the magnitude of the impacts in three categories: 1) impacts on native communities, 2) habitats and, 3) ecosystem functioning. ADR varies within five classes, ranking an alien species from low abundance in a few localities (A) to occurrence in high numbers in all localities (E). After ADR is established, three categories of impacts are considered, whose magnitude is ranked on five levels ranging from no impact (0) to massive impact (4) based on qualitative changes in an invaded ecosystem. The theoretical justification uses several well established ecological concepts, e.g. “key species”, “type specific communities”, “habitat alteration, fragmentation and loss”, “functional groups”, “food web shift”, etc. BPL aggregates the results of the assessment into five categories: “No bioinvasion impact”, “Weak”, “Moderate”, “Strong” and “Massive”.
The assessment should be performed in a defined assessment unit (a coastal lagoon, a lake, an island, etc) and for a defined assessment period. Primarily the method was designed for aquatic environment, but now it is being adapted for terrestrial species and ecosystems as well.

Implementation

The theoretical background was used to develop a system aimed at translation of existing data on miscellaneous invasive species impacts into uniform biopollution measurement units: BINPAS (Biological Invasion Impact / Biopollution Assessment System). The experimental version of BINPAS was published in early 2008. The application and database is hosted by the server of the Coastal Research and Planning Institute, Klaipeda University, Lithuania. Since then BINPAS is being developed using open source web technologies (Apache, PHP5) and MySQL relational database management system. The system is freely accessible by internet at *http://corpi.ku.lt/databases/binpas/*.

Registration to BINPAS is open for all willing to contribute with their data. On login to BINPAS a registered user can create a new assessment unit ac-

count for a certain assessment period, then to complete the assessment for an alien species estimating its ADR and ranking the impacts for either aquatic or terrestrial environment. Latin names of alien species can be selected from a predefined list of species. Taxonomic information for aquatic and terrestrial species has been adopted from databases developed in the framework of the European DAISIE and IMPASSE projects. Currently BINPAS includes 1652 aquatic alien species representing 41 taxonomic groups (at the level of Classes or Phylum) and 9629 terrestrial species of 17 taxonomic groups mostly from Europe and neighboring areas; however, it is planned to enlarge the list to cover other regions of the World.

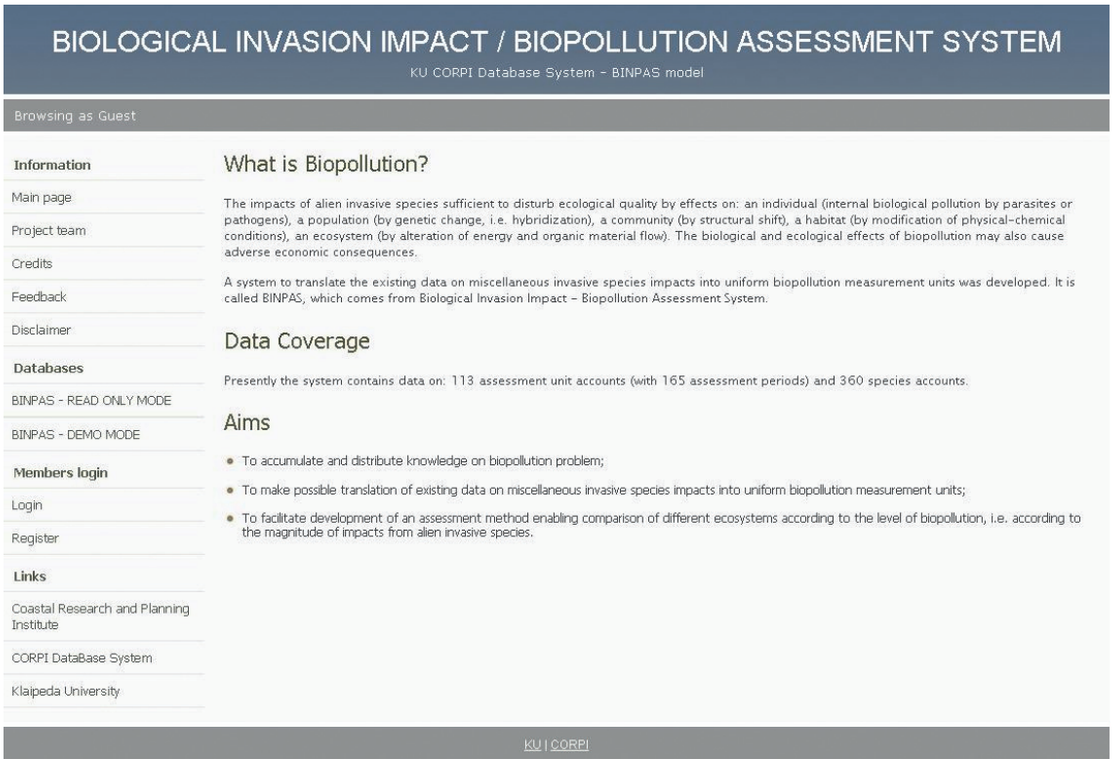
While entering the data, the registered users are required to add references and comments to justify the estimation of ADR and assessment of impacts. Also they have to estimate the level of confidence (*Low, Medium* or *High*) for presented data. Such information is being used for filtering the results. The total BPL is calculated automatically based on data entered for the assessment unit using the algorithm developed in the theoretical study (Olenin et al., 2007). It is important to stress that BINPAS is not producing new data; rather it is converting the existing data on multiple alien species impacts into uniform Biological pollution level units.

BINPAS data is also available for non-registered users (guests), which can view records, reports, diagrams, maps, etc., but not to change the database.

Current state

Currently the system stores information on bioinvasion impacts for 111 assessment unit accounts and 163 assessment periods, including data on 359 alien species impacts. So far, the data was provided by 25 contributors.

A new version of the system, BINPAS v. 2.0 was published in March 2010. This version provides such features as generating and storing bulletin of assessment accounts, effective query and search engine, displaying locations of assessment unit accounts on dynamically generated map, implementation of multi rights editorial board, etc. The system is being developed further in the framework of EU FP7 project MEECE (Marine Ecosystem Evolution in a Changing Environment) and the Lithuanian State Science and Studies Foundation project BINLIT (Biological invasions in Lithuanian ecosystems under the climate change: causes impacts and projections).



Front page from BINPAS (March 3, 2010).

Conclusion and call for cooperation

BINPAS is, probably, the first information service on alien species which integrates both data submitted by experts and active rule-sets to produce ecologically meaningful assessment of bioinvasion impacts. The BPL approach enables objective comparison between diverse invaded ecosystems, monitor-

ing of the level of bioinvasion impacts in the same ecosystem over different assessment periods and evaluation of the same invader impacts in various regions even if a limited amount of information is available. The system is growing by gaining new features to better suit the requirements of various end users.

The developers recognize that scientific credibility of such information system as BINPAS fully depends on constant update and quality control of data. It is planned to establish an editorial board to verify the assessment accounts. If needed, the editors will communicate with data contributors to specify details of their assessments; during that time the account will be suspended. In some cases, however, the editorial board may take the decision to delete a doubtful account.

We invite specialists working in the field of invasion biology, managers concerned about biodiversity losses caused by bioinvasion to contribute with their data on multiple impacts of IAS in various ecosystems.

We would be grateful for the comments and new ideas on how the system may be improved. We also encourage experts to become members of the editorial board to review assessment accounts.

Reference

Olenin S, Minchin D, Daunys D (2007). Assessment of biopollution in aquatic ecosystems. Marine pollution bulletin 55 (7-9):Sergej Olenin and Aleksas Narščius

Sergej Olenin and Aleksas Narščius
Coastal Research and Planning Institute, Klaipeda University
H. Manto 84, 92294, Klaipeda, Lithuania
E-mail: *sergej@corpi.ku.lt*
E-mail: *aleksas@corpi.ku.lt*
http://corpi.ku.lt/databases/binpas/

Giant African Land Snail (*Achatina fulica*): new entry on a list of allochtonous mollusc species in Slovakia

Jozef Šteffek & Peter Kušík

As of the beginning of the 21st century several new entries have been included on the list of molluscs of Slovakia. Majority of the species became wide spread and invasive outside their original distribution area. *Arion lusitanicus* (J. Mabile, 1868) was recorded as one of the first invasive molluscs' species in Slovakia in 1992. First observation of its massive distribution in the country is dated back in 2002 and since then the population size has multiplied (Dvořák, Čejka, 2002).

Similar scenario has been observed for the south-east Asian mussel *Sinanodonta woodiana* (Lea, 1834). First record of the species was published by Košel (1995) who found it in the Ipeľ River. Later on the species has widely spread into rivers in the southern area of Slovakia. At present it is one of the biggest freshwater mussels in Slovakia. The mussel could reach the width of 30 cm. High population density, several hundreds of thousands of specimens (Šteffek et al., 2002), of *Corbicula fluminea* (O.F. Müller, 1774) has been detected in the Slovak part of the Danube River. The average size of the mussel is 2 cm and the species is now common in the aquatic ecosystems of the Danube tributaries in the Slovak territory.

At the beginning of 2009 Dr. Horsák from the Masaryk University in Brno, Czech Republic, revised old records of the genus *Lucilla* from Slovakia and recognized the presence of the both *Lucilla singleyana* (Pilsbry, 1890) and *Lucilla scintilla* (R.T. Lowe, 1852). The latter, *L. scintilla* is North-American subterranean species first recorded in Slovakia in 1996. It was found in the deposit of the Hron River and published by Šteffek (2003) as a record of *L. singleyana.* Both the species have small shells of size up to 3 mm and have been found on three localities in Slovakia (Horsák *et al.*, in print).

In 2006 Šteffek and Ádám (2006) published a record of one individual of *Eobania vermiculata* (O.F. Müller, 1774) from the Rimavská kotlina basin. It is presumed that due to the climate change this species occurs in other parts of the country as well.

The most recently recorded invasive mollusc in Slovakia is the Giant African land snail (*Achatina fulica* Bowdich, 1822). The species was found in Veľky Krtíš on the 2nd of July 2009 in the morning. It originates in Central Africa and was introduced into Singapur as a supply for soldiers during The Second World War. From Singapur it has spread throughout the entire Asia, to the Pacific Islands, India, Australia, North America and Carribean. It is a herbivor and in many European countries it has been used commercially for a meat production. The height of a fully grown shell could reach 7 cm, the body length could be 20 cm.

Achatina fulica, an individual found in Slovakia. Photo: P. Kusik

One of the non-native but not invasive species occuring in Slovakia is *Drobacia banaticum* (Rossmässler, 1836), south-east-Carpathian species one exemplar of which was found in the alluvium of the Tisa River in the Východoslovenská nížina floodplain in 2007 (Šteffek, 2007). During the last interglacial period it was a common species throughout the whole Europe. The most northern presence of the species has been observed nearby the border between Slovakia and Hungary on the Hungarian side. It is most probable that the species will find a suitable ecological conditions and establish its stabile populations in Slovakia as well.

Any information on distribution of invasive and non-native molluscs species in Slovakia should be sent to prof. Šteffek (*steffekjozef@yahoo.com*).

References:

Dvořák L, Čejka T (2003) Invasive species *Arion lusitanicus* in Slovakia. Ochrana prírody Slovenska (/B. Bystrica) 3:8 - 9. [in Slovak]

Horsák M, Šteffek J, Čejka T Juřičková L Occurrence of *Lucilla scintilla* (R. T. Lowe, 1852) and *Lucilla singleyana* (Pilsbry, 1890) in the Czech and Slovak Republics - with remarks how to distinguished these two non-native minute snails. (in print)

Košel V (1995) The first record of *Anodonta woodiana* (Mollusca, Bivalvia) in Slovakia. Acta zool. Univ. Comenianae (Bratislava) 39:3–7.

Šteffek J (2003): Diversity of molluscs of the Hron River deposit in Šarnovica as an example of the importance of river deposits for malacology. Acta Facultatis Ecologiae (Zvolen), 10, Suppl. 1:213 - 215. [in Slovak]

Šteffek J (2007) *Drobacia banaticum* (Rossmässler, 1836) – new gastropod species in Slovakia. Natura carpathica (Ko?ice), 48: 197-198. [in Slovak]

Šteffek J, Ádám A (2006) New gastropod species in Slovakia. Chránené územia Slovenska, 2006, 70: 14-15. [in Slovak]

Jozef Šteffek
Department of Applied Ecology, Faculty of Environment and Ecology of the Technical University in Zvolen, Slovakia.
Institute of Forest Ecology, Slovak Academy of Science Zvolen, Slovakia
steffekjozef@yahoo.com

Peter Kušík
Regional Office for Environment, Ve?k? Krtí?, Slovakia
kusik@vk.ouzp.sk

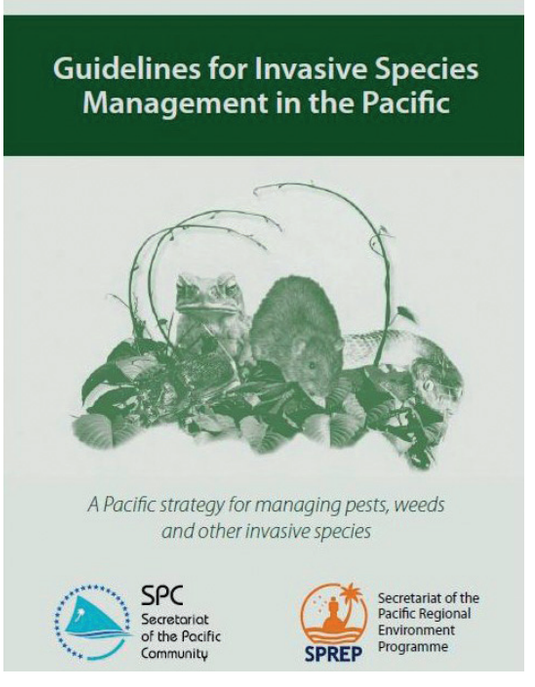
New publications

Guidelines for Invasive Species Management in the Pacific

This document lists the essential components of a comprehensive and effective invasive species management programme. It has been compiled in consultation with Pacific island countries and territories, to support them in developing their invasive species work, and to guide regional and international agencies in providing assistance to them.

In order to facilitate reference and planning, the objectives are grouped into a logical arrangement of nine main Thematic Areas in three sections. All nine Thematic Areas must be taken into account in order to achieve an effective invasive species programme, whether national or regional.

These Guidelines are intended to be comprehensive and therefore contain many objectives, but it is not suggested that any country or agency needs to carry out everything.



Not all of the objectives will be necessary for every agency or programme. Some are appropriate for implementation at a national or local level, while others require international cooperation or are more suitable for implementation by regional or international agencies. Each agency can select the objectives that are considered important for its own programme.

These Guidelines may be used as an aid in planning and designing any invasive species programme, at a local, national or regional level, to ensure that key aspects relevant to any given situation or programme are not forgotten.

The objectives have not been prioritised, because priorities and immediate needs will differ in different countries and territories. The Guidelines are intended to facilitate prioritisation by each country, territory or agency, rather than to set priorities for them.

The guidelines can be downloaded from the SPREP website *http://www.sprep.org/att/publication/000699_RISSFinalLR.pdf*

Mediterranean gardens without invasive plants

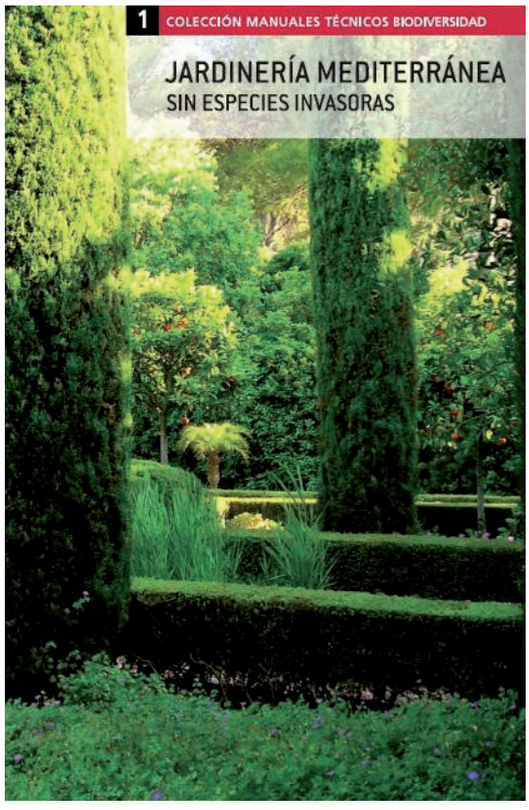
Exotic plants are an important component of European gardens since historic times. Garden lovers have always found attractive their lush foliage or unusual shapes or flowers and not least the ability of some species to grow well in water-limiting conditions or demanding environments. However, the use of these taxa is not without its risks. A good number of these plants escape garden boundaries and colonise natural environments, sometimes as aggressive invaders. In fact, recent studies have pinpointed the horticultural trade as the most important source of alien plant invaders in Europe.

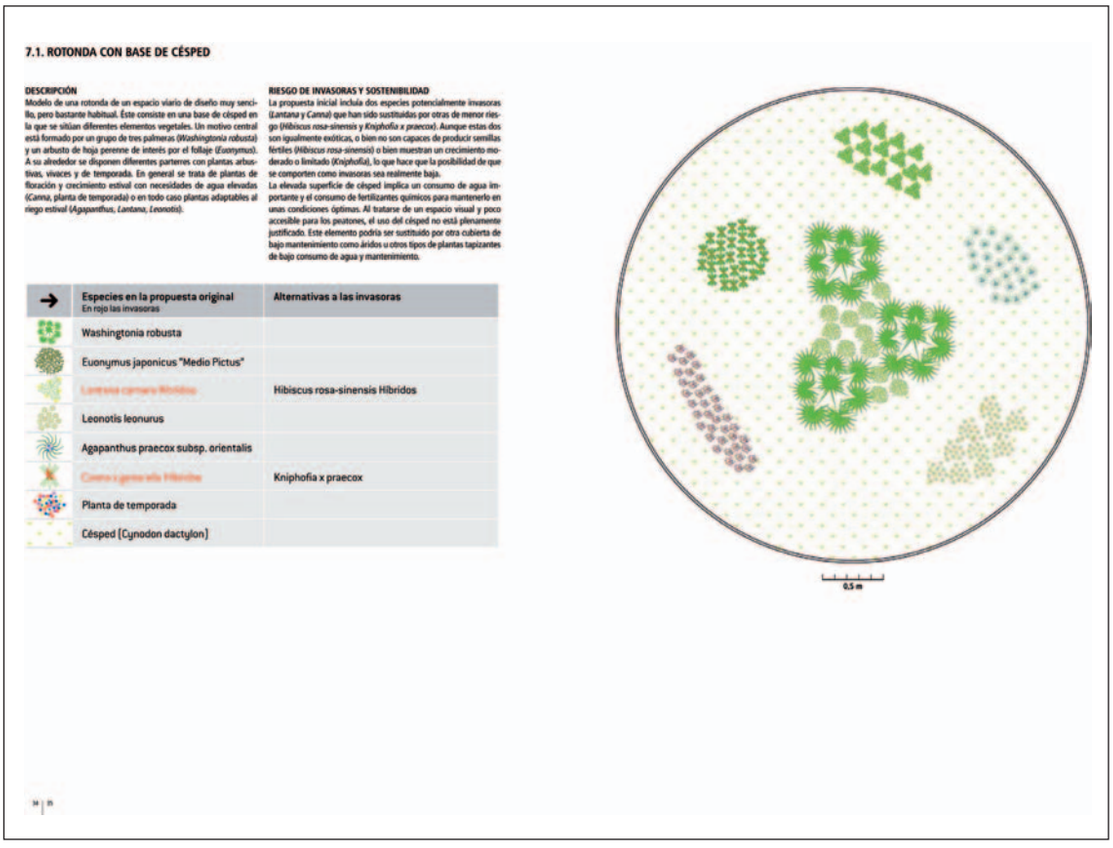
In response to the growing evidence of the risk associated with the use of certain alien plants and considering the increasingly stringent legal framework regulating the use of exotic plants in the Valencia region (East Spain), its regional government has published a manual on how to design gardens without invasive plants under the name "Mediterranean gardening without invasive species" which can be downloaded free at *http://cma.gva.es/biodviversidad*.

The main goal of this publication is to show that it is possible nowadays to design attractive gardens of all types and at all scales, for private as well as for public

areas, which combine native and exotic species available commercially and that minimise the risk posed by the use of alien plants. To achieve this objective the manual makes use of 332 indigenous and exotic plants and offers 40 ready to make garden designs that include green areas for different types of private residences, roundabouts, traffic islands, central reservations or maritime walks, but also small scale garden designs for outdoor planters and plant pots of different sizes. The book provides different examples for each of these gardens suitable for coastal or inland areas and takes into account the aspect of plantations or the availability of water resources. Throughout the book, the emphasis is put on providing alternatives to invasive plants commonly used in the Valencia region and to make it more explicit an annex at the end lists major invasives and possible alternatives depending on uses.

In summary, "Mediterranean gardening without invasive species" aims to to become a useful tool to assist in the design of sustainable gardens of all types both to amateurs, professionals and the different administrations alike by providing viable proposals from an environmental and commercial perspective to combat the serious threat posed by the use of ornamental plants with invasive potential





7.1. ROTONDA CON BASE DE CÉSPED

DESCRIPCIÓN

Modelo de una rotonda de un espacio viario de diseño muy sencillo, pero bastante habitual. Éste consiste en una base de césped en la que se sitúan diferentes elementos vegetales. Un motivo central está formado por un grupo de tres palmeras (*Washingtonia robusta*) y un arbusto de hoja perenne de interés por el follaje (*Euonymus*). A su alrededor se disponen diferentes parterres con plantas arbustivas, vivaces y de temporada. En general se trata de plantas de floración y crecimiento estival con necesidades de agua elevadas (*Canna*, planta de temporada) o en todo caso plantas adaptables al riego estival (*Agapanthus*, *Lantana*, *Leonotis*).

RIESGO DE INVASORAS Y SOSTENIBILIDAD

La propuesta inicial incluía dos especies potencialmente invasoras (*Lantana* y *Canna*) que han sido sustituidas por otras de menor riesgo (*Hibiscus rosa-sinensis* y *Kniphofia x praecox*). Aunque estas dos son igualmente exóticas, o bien no son capaces de producir semillas fértiles (*Hibiscus rosa-sinensis*) o bien muestran un crecimiento moderado o limitado (*Knipfhofia*), lo que hace que la posibilidad de que se comporten como invasoras sea realmente baja.

La elevada superficie de césped implica un consumo de agua importante y el consumo de fertilizantes químicos para mantenerlo en unas condiciones óptimas. Al tratarse de un espacio visual y poco accesible para los peatones, el uso del césped no está plenamente justificado. Este elemento podría ser sustituido por otra cubierta de bajo mantenimiento como áridos u otros tipos de plantas tapizantes de bajo consumo de agua y mantenimiento.

→	Especies en la propuesta original En rojo las invasoras	Alternativas a las invasoras
	Washingtonia robusta	
	Euonymus japonicus "Medio Pictus"	
	[illegible]	Hibiscus rosa-sinensis Híbridos
	Leonotis leonurus	
	Agapanthus praecox subsp. orientalis	
	[illegible]	Kniphofia x praecox
	Planta de temporada	
	Césped (Cynodon dactylon)	

Events

Invasive species at the Green Week Conference 2010

3 June 2010 in Brussels, Belgium

Green Week is a unique opportunity for exchanges of experience and good practice. Some 3 800 participants are expected from EU institutions, business and industry, non-governmental organisations, public authorities, the scientific community and academia.
This year, the largest annual conference on European environment policy turns the spotlight on biodiversity. Over some 30 sessions, the conference will address the state of **biodiversity** and nature in Europe and the world, the benefits they bring, present-day pressures on them, and possible solutions to the current rates of loss. The path to be taken by EU policies on biodiversity and nature policies post-2010, the economic dimension of biodiversity, ecosystem services and Natura 2000 will also be investigated.

Invasive species (or invasive alien species, IAS) are among the many questions Green Week 2010 will examine in three days of discussion and debate between high-level speakers from Europe and beyond. The European Commission is currently working on an EU policy to combat invasive species, built on the internationally accepted 'hierarchy' of prevention, early detection, eradication, and management.

This session – scheduled on Thursday 3 June 2010 - 11:30 – 13:00 - will start off by presenting the background to the problem, including examples of damage caused by invasive species in various ecosystems around the world. It will then present ways in which the challenge has been dealt with in several countries. Finally the ongoing work to develop an EU strategy will be discussed.

Speakers:
Philip E Hulme, Professor of Plant Biosecurity, The Bio-Protection Research Centre, NZ
Piero Genovesi, Chair, Invasive Species Specialist Group, Institute for Environmental Protection and Research, International Union for Conservation of Nature (IUCN)
Clare Shine, Associate, Institute for European Environmental Policy and Barrister, and Consultant in Environmental Policy and Law
Moderator:
Rick Thompson, Former BBC International News Editor

Further information can be obtained at:
http://ec.europa.eu/environment/greenweek/

International workshop on "New approaches for assessing the impacts of non-native freshwater fishes in the Mediterranean region"

26–29 October 2010 in Muğla, Turkey

Freshwater fish communities of the Mediterranean region are characterized by a high level of endemism relative to other parts of Europe. This makes the region particularly vulnerable to reduced biodiversity due to introduced species, especially under conditions of climate change. The aim of this workshop will be to examine new methods and techniques for assessing impacts and in doing so summarize existing knowledge and identify gaps in knowledge of adverse impacts exerted by introduced freshwater fish in the Mediterranean region. Of particular interest are investigations that focus on real impacts, whether direct or indirect, to native species and/or ecosystems, including ecosystem function and the forecasting of impacts under conditions of climate change.

The workshop is intended to inform government departments concerned with the communication, management, regulation, mitigation and control of non-native freshwater fishes as well as anglers and professional fisherman who are likely to encounter or deal with non-native freshwater fishes.

Further information can be obtained at:
http://neofishmed.com/
Workshop contact:
Dr. Serhan Tarkan
Mugla University, Faculty of Fisheries
Phone: +90 252 211 18 88, fax: +90 252 223 84 75
eMail: *serhan@mu.edu.tr*

III International symposium «Invasion of Alien Species in Holartic»

5-9 October 2010 in Borok-Myshkin, Yaroslavl District, Russia

This is the third symposium in a series that took place at the Papanin Institute of Inland Waters,

Russian Academy of Sciences (Borok) in 2001 and 2005. This meeting will involve a wide range of theoretical and applied aspects of biological invasions

The main scientific topics of symposium are**.**
• Theoretical issues of biological invasions.
• Dynamics of biological invasions in Holartic in space and time.
• Genetics and evolution of biological invasions.
• Influence of alien species on indigenous species and communities.
• The role of global geoclimatic and anthropogenic processes in biological invasions.
• Information systems for the monitoring of invasions. • Mathematical modelling of species invasions.

Our scientific programme includes several round tables with presentations by leading researchers on the following topics:
• Methods for the study of biological invasions.
• Methods of control and eradication of invasive species.
• Social and political aspects of biological invasions.
• International and regional collaboration in alien species studies.

Further information can be obtained at:
http://www.sopsr.sk/publikacie/invazne/doc/Prve_oznamenie_IASH.pdf

2nd International Invasive Bird Conference

7 to 9 March 2011 in Cape Town, South Africa

The conference will be hosted by the Percy FitzPatrick Institute of African Ornithology, based at the University of Cape Town together with the Centre for Invasion Biology at Stellenbosch University. The 2011 IIBC follows the successful 1st International Invasive Bird Conference held in Fremantle, Australia, in December 2008.

Appropriate management responses to avian invasives depend on improved understanding and quantification of patterns and consequences of establishment and invasion. The conference is organised in partnership with BirdLife South Africa, the South African Working for Water Programme, Dept of Agriculture and Food Western Australia, the Animal Demography Unit (University of Cape Town), WildWings (UK), Ingrip Consulting (Germany) and the City of Cape Town. The aim will be to explore developments in invasive bird biology, to assess the level of understanding of the different facets of bird invasions and our ability to manage them, and to discuss priorities for the future.

The programme will be structured to address key themes presented through keynote talks, oral and poster presentations. We have confirmation from keynote speakers, Tim M. Blackburn, Zoological Society of London, UK, Chris J Feare, WildWings Bird Management, UK and Phil A.R. Hockey, Percy FitzPatrick Institute, South Africa, and trust that we will be able to introduce the other speakers soon.

Further information can be obtained at:
http://www.iibc2011.co.za/

23rd Asian-Pacific Weed Science Society Conference

25 – 30 September 2011, in Sebel Cairns, North Queensland, Australia

The Asian-Pacific Weed Science Society Conference returns to Australia for the third time in 2011 and will focus on the theme “Weed Management in a Changing World”. The Conference is the only international weed management conference to be held in Australia since the early 1990s and the only major national Conference in three years.

There will be presentations on climate change, lack of water, Biosecurity, population growth and the utilisation of weeds in the future.

Field trips will be organised to demonstrate weed issues affecting Northern Queensland, Australia and activities undertaken to reduce their impact. These

will be selected based on their applicability throughout the Asia Pacific region.

There will be ample time available for networking and discussions during breaks in the program and through a social program incorporating a Welcome reception, Conference dinner and Field Trips.

The aim of the Conference is to bring people involved in weed management together from throughout the Asia Pacific and Australia to network with industry colleagues.

Further information can be obtained at:
http://www.apwss2011.com/

2nd International Workshop Invasive Plants in the Mediterranean Type Regions of the World

2-6 August 2010, in Trabzon, Turkey

The first workshop was successful and allowed many exchanges between participants and opportunities to discuss specific and concrete topics; the second workshop is organized in the same spirit.

This Workshop therefore has the objective to be:

• a global platform for networking,
• an opportunity for discussing specific plant invasions issues,
• a place to learn about varied topics such as management options, biology of invaders and ecology of invasions, prediction and mapping, prevention, ranking and risk assessment, political options, legislative tools, invasions in small islands, early warning, control and containment, education and awareness raising.
• a chance for raising awareness on biological invasions in the Mediterranean Type regions of the World.

This workshop will be co-organized by:
• The European and Mediterranean Plant Protection Organization
• The European Environment Agency
• The Council of Europe
• The University of Idgir
• The Turkish Ministry of Agriculture

This Workshop is open to civil servants within Governments (NPPOs, Ministries of Environment), researchers, the horticultural industry and trade, land managers, etc. The workshop will consist of 2 days of presentations and discussions, and will be followed by 2 days of field work to form the basis for local inventories of the exotic flora of the Trabzon area and to contribute to the knowledge on invasive alien plants by hands on activities.

Further information can be obtained at:
http://archives.eppo.org/MEETINGS/2010_conferences/mediterranean_ias.htm

Symposia on "Ecologic and controls for the eradication of Invasive Species"

8-12 August 2010 in Buenos Aires, Argentina

The symposia is organized inside the frame of the IV Bi-National Meeting on Ecology (Argentina – Chile), to promote the integrated approach for the control of invasive species (including the discussion on the "Beaver Eradication Bi-National Project").

Chile and Argentina recognize the need for controlling invasive species as a mechanism to conserve and restore native ecosystems. In addition, they have identified also the importance of developing control programs in valuable ecosystems, as a way to halt ecological and economical negative effects coming from this threat.

The implementation of successful programs for the control of alien species requires knowledge of the ecosystems and the species subject to management. Considering that most of the management tools applied to invasive come from the ecological theory, this theory-practice relationship has not been deeply studied in both countries. Taking into account also that both countries share political borders, history and biology, the management of this problem has to be coordinated too.

The symposia is organized by the National Administration of Parks (Argentina), the Secretariat of Environment (Argentina), the National Commission of Environment (Chile) and the Wildlife Conservation Society, Chile/Argentina.

For more information, please contact Fernanda Menvielle - National Administration of Parks (Argentina) *menvie@retina.ar*

Further information can be obtained at:
http://www.ege.fcen.uba.ar/rbe2010/index.php

Aliens: The Invasive Species Bulletin **Issue Number 29, 2010**

CONTENTS