

Aliens

the invasive species bulletin

Newsletter of the IUCN/SSC Invasive Species Specialist Group

ISSUE NUMBER 33 ▲ 2013



100th of the worst



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FRONT COVER PHOTO

Salvinia mat

© Photo by Kevin Roberts

Salvinia youngsters up close

© Photo by Geoffrey Howard

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EDITORIAL

At the start of my second quadrennial as chair of the IUCN SSC Invasive Species Specialist Group we are at the start of an exciting phase in the activities of the group: the revision of the Global Invasive Species Database is almost completed; we have redesigned our newsletter, as you can see from the issue you hold in your hands; and I think I can say that we have an increasingly recognised role at the global level, as confirmed by the very fruitful collaborations we are having with key global institutions, including in particular the Secretariat of the Convention on Biological Diversity. We have also had important results in terms of communicating invasive species issues to the public, as shown by the success of the campaign to select the new 100th species to be included in the ISSG list of '100 of the World's Worst Invasive Species'; details of the campaign were published in *Nature* and are reported in this issue. The success of ISSG and the many positive results we have achieved in these past years have only been possible thanks to the efforts of all the members of our group, and the wider community of subscribers and supporters of the groups work. So I take this chance to thank all ISSG members for their continued commitment to support the work we do. I would also like to take the opportunity to welcome new members of the group, who I am sure will help us in strengthening our global role in the struggle against the effects of biological invasions and for achieving Aichi Target 9 by 2020.

Indeed it takes time – in some cases a very long time – before we see the results of our efforts, as some of the stories reported in this issue show well. I just realised that the first issue of *Aliens*, dated back to 1995 reported articles on: the program to eradicate goats from Aldabra island, Seychelles, in the Indian Ocean-the second largest atoll in the world; risks related

of the presence of the grey squirrel in Italy; and problems related to the presence of the Ruddy duck in Britain. In this issue you can read of the successful completion of goat eradication in Aldabra, some partly encouraging news from Italy - where the trade of the grey squirrel has been finally banned (although the removal of this highly invasive species still faces strong public opposition) - and, in a previous newsletter we have reported on the successful eradication of the Ruddy duck from Great Britain, which is now almost completed.

If successes in the management of invasive species take a long time to realise, influencing policy can be even slower. In this issue you will read that the European Commission has finally adopted a proposal for an EU regulation on invasive species, eventually responding to a commitment taken over six years ago. The proposed legislation follows the European Strategy on invasive species, on which I have worked since 1999, with Clare Shine - another very active ISSG member -; this was adopted by the Council of Europe 10 years ago. So, I think I can say that the new legislation is partly the result of the efforts of ISSG. We are committed to continue working with European institutions in the following years to try and influence the complicated process of approval of this proposed legislative tool.

Let me say that the only lesson we should learn from these stories is that we should never give up, and that with the enthusiasm and commitment that have always characterised our community, we can achieve important results, even if this can take a long time.

Piero Genovesi, ISSG Chair

GENERAL DISCLAIMER

All material appearing in *Aliens* is the work of individual authors, whose names are listed at the foot of each article.

Contributions are not refereed, as this is a newsletter and not an academic journal. Ideas and comments in *Aliens* are not intended in any way to represent the view of IUCN, SSC or the Invasive Species Specialist Group (ISSG) or sponsors, unless specifically stated to the contrary. The designation of geographical entities do not imply the expression of any opinion whatsoever on the part of IUCN, SSC, ISSG or sponsors concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.



NEWS FROM THE ISSG



Braulio Ferreira de Souza Dias, Executive Secretary of the Convention on Biological Diversity; Jane Smart, Global Director IUCN Biodiversity Conservation Group; and Piero Genovesi, Chair of the IUCN SSC Invasive Species Specialist Group sign the agreement.

ISSG and the Convention on Biological Diversity

A Memorandum of Cooperation (MoC) was signed by partners, including the IUCN/ ISSG at the launch of the Global Invasive Alien Species Information Partnership (GIASIPartnership), at a side event in Hyderabad, India during the 11th meeting of the Conference of the Parties (COP 11). The MoC was co-signed by Braulio Ferreira de Souza Dias the Executive Secretary of the Convention on Biological Diversity (CBD), Jane Smart, Global Director IUCN Biodiversity Conservation Group, and Piero Genovesi Chair of the ISSG, formally acknowledging the support of the IUCN/ ISSG to the CBD on invasive species.

The GIASIPartnership has come together in order to assist Parties to the CBD, and others, implement Article 8(h) and Target 9 of the Aichi Biodiversity Targets - "By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment"

Two important activities that the ISSG has initiated have been supported and co-funded by the CBD through the Partnership- they include the Global Register of Introduced and Invasive

Species (GRIIS) and the Invasive Alien Species Pathways Management Resource. ISSG is working with several partners CAB International; DAISIE (Delivering Alien Invasive Species Inventories for Europe); Centre for Ecology and Hydrology (CEH) UK; the BERN Convention; FishBase; the European Network on Invasive Alien Species (NOBANIS); the National Invasive Species Council USA; Horus Institute, Brazil; the Global Biodiversity Information Facility (GBIF) and several country partners in developing and maintaining these resources.

GRIIS will provide annotated country inventories of introduced and invasive species; annotations include taxonomy, biological status of the species in that country and a Yes/No on evidence of environmental and/or socio-economic impacts. It is envisaged that GRIIS will support countries in developing their National Biodiversity Strategies and Action Plans (NBSAPs), National Invasive Species Strategies and Action Plans (NIS-SAPs) and their bio security legislation and regulations. It will also assist countries in formulation and prioritizing invasive species management action.

The further development and enhancement of the key invasive species information resources developed and managed by the ISSG address information gaps faced by countries and conser-

The GIASIPartnership Gateway Invasive Alien Species Information Services



vation agencies in making progress towards achievement primarily of Target 9 and Targets 5, 11, 12 and 17. ISSG will be presenting demonstrations of these tools during a GIASIPartnership side event at the Seventeenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the CBD in Montreal in a few weeks!

ISSG is a partner in the Biodiversity Indicators Partnership (BIP) leading the development of global Invasive Species Indicators. Six indicators have been identified for measurement. The development of at least two headline indicators are underway 'Trends in the numbers of invasive alien species' and responses to this pressure in the form of legislation and management of pathways of introduction and spread of invasive species. Other partners include IUCN, BirdLife International Monash University, Concordia University and Island Conservation.

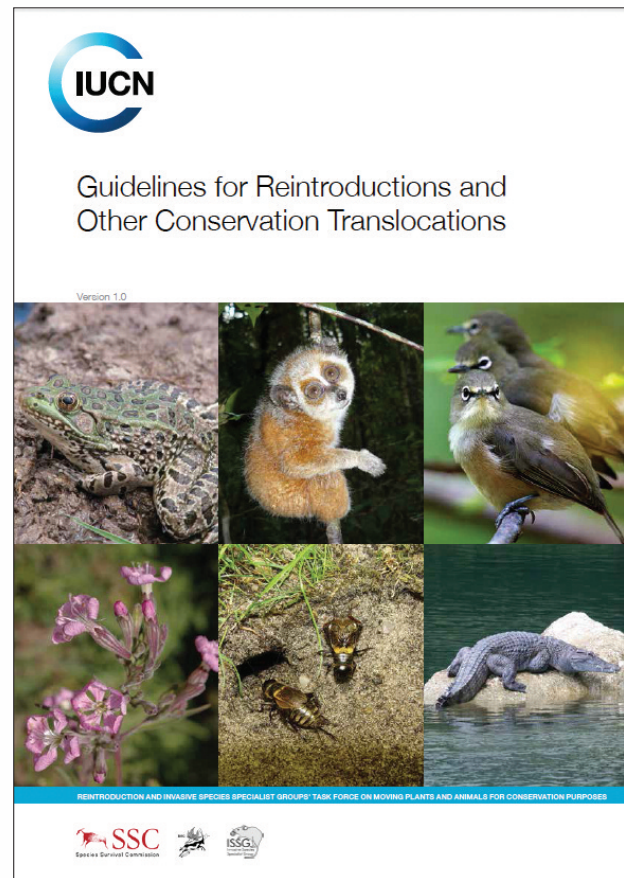
ISSG is working with the Biodiversity and Protected Areas Management Programme (BIOPAMA) to enhance the Island Biodiversity and Invasive Species Database (IBIS) that documents information on the impacts of invasive species on native island biodiversity and natural areas including management action at the island and site level. IBIS will form an important part of the planned Regional Observatories in the Pacific and Caribbean regions.

ISSG in Oceania is assisting countries in developing their NIS-SAPs by developing baseline information on natural areas and biodiversity and impacts of invasive species. ISSG is currently

working with the Kingdom of Tonga, Vanuatu, Niue, and the Cook Islands.

ISSG has assisted in the development of the IUCN Guidelines for Reintroduction and other Conservation Translocations (with the Re-introductions Species Group), and the Guidelines for Wildlife Disease Risk Analysis (with the Conservation Breeding, Wildlife Health and Re-introduction Specialist Groups).

ISSG, in cooperation with the IUCN World Commission on Protected Areas, is developing guidelines on the management of invasive species in protected areas. It is planned to present the Guidelines at the World Park Congress in 2014.



IUCN Guidelines for Reintroduction and other Conservation Translocations (available online here: <http://data.iucn.org/dbtw-wpd/edocs/2013-009.pdf>)



Monk parakeet (*Myiopsitta monachus*). Photo: Riccardo Scalera



The role of zoos and aquaria in relation to IAS

ISSG in Europe has played a leading role in the development of various voluntary codes of conduct aimed at preventing the introduction of invasive species through some well-known pathways. So far, in collaboration with the European Association of Zoos and Aquaria (EAZA), the Bern Convention and the ISSG have developed the European Code of Conduct for Zoological Gardens and Aquaria on Invasive Alien Species.

The objective of this document is to provide guidance to zoological gardens and aquaria to strengthen their role for biodiversity conservation in Europe, by 1) Preventing the introduction and spread of IAS and related pathogens and diseases; 2) Promoting the need to raise awareness on biological invasions; 3) Supporting IAS related research projects and other relevant conservation initiatives.

The code has been formally approved at the last Standing Committee meeting of the Bern Convention on 30 November

2012. At the same meeting, with the aim of ensuring responsible and proactive policies and applying these in a coherent manner across Europe, the Standing Committee praised the innovative approach of such voluntary instrument, and adopted the Recommendation No.161 (2012). The aim is to invite all Bern Convention parties to implement the code, by drawing up their own national codes of conduct based on the European version, and by collaborating with zoological gardens and aquaria in implementing good practices aimed at preventing the spread of invasive alien species. The code will also support the implementation of the EU Regulation on IAS recently proposed, which requires Member States to draw up action plans to manage IAS pathways.

Another major achievement of the new code has been the formal acknowledgement received by the recent 11th Conference of the Parties of the CBD held at Hyderabad (India, 8-19 October 2012) which in its Decision XI/28. Invasive alien species: “welcomes the development of voluntary codes of conduct on these separate pathways, such as the “Code of conduct on zoo-

logical gardens and aquaria and invasive species” developed by the Bern Convention, the IUCN Invasive Species Specialist Group and the European Association of Zoos and Aquaria, and requests the Executive Secretary to compile information and to work with experts to avoid and/or minimize the risks particular to these separate pathways”.

You can download the full document here:

<https://wcd.coe.int/com.instranet.InstraServlet?command=com.instranet.CmdBlobGet&InstranetImage=2176840&SecMode=1&DocId=1943806&Usage=2>

Urban areas and biological invasions

On 5 September 2013 the IUCN has organised a conference on "Invasive alien species: the urban dimension" in Gland, Switzerland. With this event - supported by Deutsche Bundesstiftung Umwelt and the Swiss Federal Office for the Environment - the IUCN has brought together key actors from all over Europe for a conference aiming to exchange knowledge and best practices to reduce the risk of invasive alien species in urban areas.

Urban areas are particularly affected by IAS, because they present important entry pathways that lead to introduction of invasive species (e.g. pets, ornamental plants, accidental arrivals in harbours or airports) and their further spread beyond the urban environment. Cities, local and regional authorities and other urban actors have a critical role to play in fighting biological invasions, by preventing their introduction, implementing control and management measures, and raising awareness with citizens and decision-makers. As metropolitan areas are particularly vulnerable to IAS and serve as entry pathways, the key objective of the event was to analyse the issue of IAS from an urban perspective to understand the challenges which cities face and present solutions. The conference served as an opportunity to share examples, establish cooperation and strengthen action for the prevention, control and management of invasive alien species across Europe.

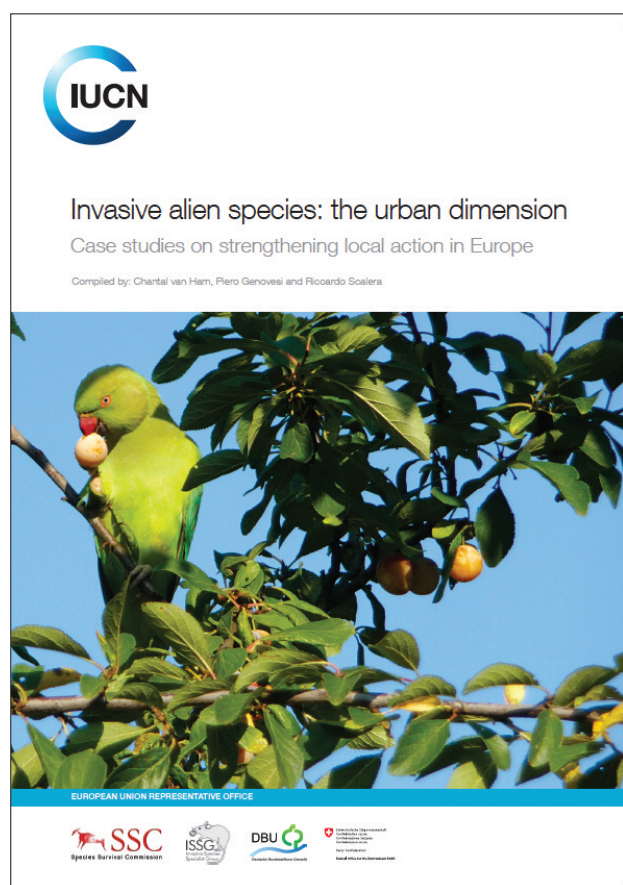
A key output of the conference was the IUCN report "Invasive alien species: the urban dimension". The IUCN report includes 26 case studies aimed at providing insights on problems, challenges, actions, approaches, human and financial resources,

and lessons learnt, for a selection of species and countries. In addition, as a result of the plenary presentations and the interactive discussions, IUCN Europe has developed a list of Recommendations, which is made available online on the IUCN Europe website together with the conference materials:

- Agenda
- Abstracts and biographies of speakers
- Presentations by speakers
- Summary of break-out sessions

Here you can read the full story, download the report, and access all the information:

<http://www.iucn.org/about/union/secretariat/offices/europe/?13708/Urban-areas-and-biological-invasions-what-can-cities-do-about-it>



The front cover of the IUCN report on IAS and urban areas (available online here: <http://data.iucn.org/dbtw-wpd/edocs/2013-027.pdf>)



...AND OTHER NEWS

The new EU regulation on IAS

In September 2013 the European Commission has proposed a new regulation to prevent and manage the rapidly growing threat from invasive alien species.

The proposal centres round a list of invasive alien species of Union concern, which will be drawn up with the Member States using risk assessments and scientific evidence. Selected species will be banned from the EU, meaning it will not be possible to import, buy, use, release or sell them. Special measures will be taken to deal with issues arising for traders, breeders or pet owners in the transitional period.

The proposal is for three types of intervention:

- **Prevention:** Member States will organise checks to prevent the intentional introduction of species of concern. However many species come into the EU unintentionally, as a contaminant in goods or trapped in containers. Member States will have to take action to spot such pathways and take corrective measures.
- **Early warning and rapid response:** when Member States detect a species of Union concern that is becoming established, they will take immediate action to eradicate it.
- **Management of established invasive alien species of concern:** if species of Union concern are already widely spread, Member States will need to put in place measures to minimise the harm they cause.

The proposal encourages a shift towards a harmonized and more preventive approach, increasing efficiency and lowering damage costs and the cost of action over time.

IUCN, uniting some of the leading experts on this subject in Europe, welcomes the new proposal but highlights some concerns. For example, the cap proposed by the European Commission of maximum 50 species of Union concern is far too low to achieve the EU and global biodiversity targets. Also, the proposed timeline of 5 years for the possible revision of such list does not guarantee the flexibility required for early response to new threats.

The proposed Regulation will now be examined by the Council and the Parliament. Member States will be fully involved in compiling the list and can propose candidates for listing. IUCN hopes that such process will result in a strengthened and concerted legislative instrument and that it will not be postponed until after the elections next year. IUCN will continue providing

scientific information and facilitating dialogue among stakeholders on this very urgent matter.

For more information:

http://ec.europa.eu/environment/nature/invasivealien/index_en.htm
<http://iucn.org/about/union/secretariat/offices/europe/?13634/European-Commission-move-to-tackle-invasive-species-a-good-start-but-more-needed>

ALTER-Net conference 'Science underpinning the EU 2020 Biodiversity Strategy'

Between 15 and 18 April 2013 ALTER-Net (*) organized, in close collaboration with the EU Directorate-General for the Environment (DG-Env), its conference 'Science underpinning the EU 2020 Biodiversity Strategy' in Ghent, Belgium.

The conference primarily focused on the objectives and targets of the EU's 2020 Biodiversity Strategy, which should be realized by the end of this decade. Being a science-policy interface network, ALTER-Net wanted to help the EU in realizing these targets by providing scientific knowledge, e.g. by pointing out possible weaknesses, opportunities and necessities, and by helping to find solutions and evidence-based actions. The programme of the conference featured half-day sessions on each EU target and included a mix of oral presentations and workshops. The workshops aimed to result in workable recommendations that are application-aimed, science-underpinned, and as much as possible, evidence-based. Target groups are EU-policy makers and anyone else involved in the implementation and realization of the EU-targets. Also, Target 5 – addressing the problem of Invasive Alien Species, was covered. With the help of key note presentations by Myriam Dumortier (European Commission, DG-Env), Helen Roy (Centre for Ecology and Hydrology, England), Jan Pergl (Institute of Botany, Academy of Sciences of the Czech Republic, Czech Republic), Hanno Sandvik (Norwegian University of Science and Technology, Norway) and Isabelle Mauz (Irstea, France) the workshop resulted in recommendations formulated by a group of about 50 participants working or familiar with the issue of Invasive Alien Species.

The main conclusion of the session was that policy should aim at the broad impact of Invasive Alien Species on native biodiversity, health and food production and their interaction with these, rather than on the sole criterion of being alien. The first

short-term challenge is to develop legal and economic instruments, which are currently being worked out by the policy makers. The second challenge is to fill in the legal instruments with the help of combining scientific efforts when it comes to integrating and linking different databases, web portals and other data collections and including evidence based science. Furthermore the workshop addressed 4 issues: how to make the best prioritisations when it comes to regulations and management plans; how to balance our efforts with other stakes such as climate change and economy; future challenges when a similar species but genetically different from the original species becomes invasive and outcompetes the original species; how to build upon existing surveillance and monitoring systems such as citizen science.

When it comes to prioritisation for regulations and management plans, the recommendation was that scientists need to work on baselines to be able to compare the different (damaging) impacts. Work should be done on systematic data collection for empirical evidence of the risk assessments and how and when species changes or have changed from being a low risk species to a high risk species. Emphasis should be on collecting a burden of proof. Policy however should focus on the precautionary principle, but also on the regulations of already existing invasions (e.g. regional black (forbidden)/grey (monitored)/white (allowed) species lists).

With regard to balancing our efforts with other stakes 4 recommendations were formulated: 1) Focus on observatories and collecting evidence (evidence-based science) on impact on socio-economy, biodiversity, ecosystem functioning; 2) Because future risk assessments are difficult, we need to focus on documented risks in closely related and/or demographically/ecologically similar species (Evidence-based science) and work on the precautionary principle. Evidence-based science can furthermore help in scenario work for future risk assessments; 3) Work on strengthening existing ecosystems and make/keep them resilient and robust so they can 'defend' themselves against IAS; 4) Do not allow the introduction of alien species for the mere purpose of replacing natives as this amounts to a natural experiment with unforeseeable and unnecessary risks.

The discussion on out-competition and becoming invasive, it was decided that it is important to distinguish between natural movement of a species and the deliberate/artificial introduction of a species in a certain area. But insight is needed into what is 'genetic pollution' and when it occurs. Is losing ge-

netic variability harmful? We need to indicate what is happening in nature anyway and anyhow and keep in mind the adaptation capacity of native populations.

The participants also agreed not to (mis)use citizen science as a general and easy data collection tool but that we should work out specific targeted potentials within the big box of 'citizen science' and concentrate on those. However the effect of public involvement is poorly investigated and largely unknown and therefore long-term studies are necessary. Also studies on how public opinion is influenced are needed.

The session on Target 5 – addressing the problem of Invasive Alien Species – resulted in 9 recommendations as described above. For the specific formulation of the Target 5 recommendations and for information on the recommendations of the other 5 EU targets session, please look at <http://www.alter-net.info/outputs/conf-2013>.

() ALTER-Net brings together 26 leading scientific institutes from 18 European countries. They share the goal of integrating their research capability to assess changes in biodiversity, analyse the effect of those changes on ecosystem services and inform the public and policy makers on the issues at a European scale. Originally funded by the European Union's Framework VI program to stimulate a collaborative approach, ALTER-Net is now operating independently. See www.alter-net.info for more information.*

JISKA VAN DIJK

Norwegian Institute For Nature Research

Red-whiskered bulbul eradicated from Aldabra

In July 2013, the Seychelles Islands Foundation (SIF) completed their second invasive species eradication on Aldabra Atoll in less than a year when staff caught a single introduced red-whiskered bulbul *Pycnonotus jocosus* that has eluded capture efforts for almost a year.

The red-whiskered bulbul and a small population of introduced Madagascar fodies were discovered in the remote Takamaka area of Aldabra in March 2012. Both species are thought to have colonised from the nearby island of Assumption, where they were introduced from Mauritius in the 1970s. Assumption now hosts large populations of both species and eradication





Team Leader of Takamaka Eradication, Terence Mahoune, with the red-whiskered bulbul on Aldabra. Photo: J. Raguin

efforts there aimed to eliminate the threat of their introduction to Aldabra's avifauna.

Since then, an intensive eradication programme has been launched with the support of UNESCO Emergency Funding. Initial activities focussed on observations and setting up a field base in the area from which a permanent eradication team could be based. Following this, full-time eradication of the two species was started in January 2013. Although there appeared to be only a single red-whiskered bulbul, the bird proved extremely difficult to catch, despite targeted efforts. Eventually, in mid-July 2013, the SIF team of Terence Mahoune and Jeremy Raguin identified where the bird was roosting and managed to catch it in a mist-net. They subsequently confirmed that there were no other red-whiskered bulbuls present. Following the successful feral goat eradication in 2012 (see

article in this issue), the capture of this bird marks another invasive species eradication success for SIF. Aldabra was thought to be one of the largest tropical islands in the world with no introduced bird species prior to the discovery of red-whiskered bulbuls and Madagascar fodies at Takamaka. Re-gaining and maintaining Aldabra's status of free of introduced birds in the long-term, however, depends on further eradication successes on both Aldabra and Assumption.

**NANCY BUNBURY, TERENCE MAHOUNE,
JEREMY RAGUAIN, HEATHER RICHARDS
& FRAUKE FLEISCHER-DOGLEY**
Seychelles Islands Foundation



The Giant Salvinia (*Salvinia molesta*): the 100th among some of the worst

FRANCK COURCHAMP

The Giant Salvinia (*Salvinia molesta*), an aquatic fern, has been recently added to the list of 100 of the World's Worst Invasive Alien Species.

Compiled by the IUCN Species Survival Commission Invasive Species Specialist Group, (ISSG). The famous IUCN list of the "100 of the World's Worst Invasive Alien Species" has been a formidable communication tool since its creation in 1999. The aim of the list is to increase awareness about invasive alien species and to help prevent further invasions.

Recently, the list was reduced to 99 species following the eradication of the Rinderpest Virus from the wild and a review was conducted to decide which invasive species should be added. This provided the invasion biologist community with a unique opportunity to communicate about this important list and about alien invasive species in general. Selecting a new candidate to fill in the 100th place on this list would indeed help raising awareness about yet another problematic invader, but also about biological invasions in general.

The review involved more than 650 experts from 63 countries and was conducted by a team of expert including Piero Genovesi of the IUCN-ISSG, Dan Simberloff of the University of Tennessee and the group of work of Franck Courchamp at the University of Paris South. More than 10,000 invasive species were assessed in terms of their capacity to spread and their potential ecological or economic impact. This large number of species were selected from inventories/checklists of 16 important databases. These were three large, international databases (GISD, DAISIE and CABI Invasive Species Compendium) and 13 major national databases (Argentina, Australia, Belgium, Botswana, Canada, China, Japan, Malawi, Mauritius, New Zealand, South Africa and USDA USA).

All the invasive alien species were ranked based on the number of times they were listed in these databases. Another aspect considered in the process of ranking was the emerging threats, i.e. species that are not yet widespread but that are known to have major impacts and/or a high spread rate. This procedure allowed to account for species that are newly invasive, thus not yet listed in many databases, but that could become cosmopolitan in the short term. The first 50 species were finally selected and to each a spread score was assigned, based on the number of continents already invaded. An impact score, related to their effects on ecological, economic and/or health, was also added. Finally all those species whose

genus was already represented in the 100-list, as well as those that had a strong positive value (cultural or economic) was eliminated. In this way the 10 species with the highest scores were selected.

These 10 species were not biased in terms of taxonomy, ecosystem or geography. They were six aquatic and four terrestrial organisms, five plants and five animals. They came from South and North America, Asia, Europe and Oceania, and all had strong ecological, economic and/or health impacts. Below we provide, in alphabetical order, a sketchy description of each.

- *Ailanthus altissima* is a small to medium-sized tree of the mostly tropical Quassia family, from Asia. It is a very prolific seed producer that grows rapidly and can overrun native vegetation. It produces toxins that prevent establishment of other plant species.
- *Alternanthera philoxeroides* is a perennial stoloniferous herb from South America that is now found in many parts of the world, infesting rivers, lakes, ponds and irrigation canals, as well as many terrestrial habitats.
- *Bursaphelenchus xylophilus*, also called the pinewood nematode, comes from North America and causes the pine wilt disease that harms pine trees and other conifers. Vectors of this nematode are long-horned beetles, especially those in the genus Monochamus.
- *Corbicula fluminea* is a freshwater clam that spreads when it is attached to boats or carried in ballast water. Used as bait, sold through the aquarium trade, and carried with water currents, it spreads from its native Asia to the rest of the world. It outcompetes native clams for food and space, and it damages intake pipes used by power, water, and other industries.
- *Dikerogammarus villosus* is a crustacean from Europe. This voracious predator kills a range of invertebrates, particularly native shrimps and young fish, sometimes causing their extirpation. It tends to dominate its habitat, killing and maiming unselectively.
- *Elodea canadensis* is a submerged, rather densely bushy, aquatic perennial that grows and multiplies fairly rapidly in diverse habitats and conditions and has spread rapidly and easily throughout the world. Originating in North America, it alters habitat, competes with native species, and threatens biodiversity.
- *Heracleum mantegazzianum* is an enormous herb that may





Figure 1. Bed of *Salvinia molesta* in Namibia.
 Photo: Kevin Roberts, Department of Water Affairs and Forestry in the
 Ministry of Agriculture, Water and Forestry, Namibia

reach 6 meters in height. Originating in Asia, it is most common on roadsides, along streams and rivers, and in vacant lots. It forms a dense canopy, outcompeting native riparian species and increasing soil erosion along the stream banks where it occurs. It is also a serious human health concern, its sap causing severe skin inflammations.

- *Pterois volitans* is a beautiful but dangerous tropical fish that has spread to new marine environments through the aquarium trade. In the absence of predators, the Indo-Pacific red lionfish has the potential to displace commercially important species such as groupers and to reduce recruitment of juvenile fishes, which in turn disrupts marine ecosystem processes. It is thought currently to have one of the fastest spread rates of all invasives and is rapidly establishing all over the Caribbean.
- *Python molurus bivittatus* is a nocturnal predator that kills its prey by constriction. Native to Asia, it is the largest and

most water-dependent of the *Python molurus* subspecies, though it lives on land or on trees when juvenile. It threatens native species of amphibians, birds, lizards, snakes, and mammals in Florida, USA, where it is becoming an alarming problem.

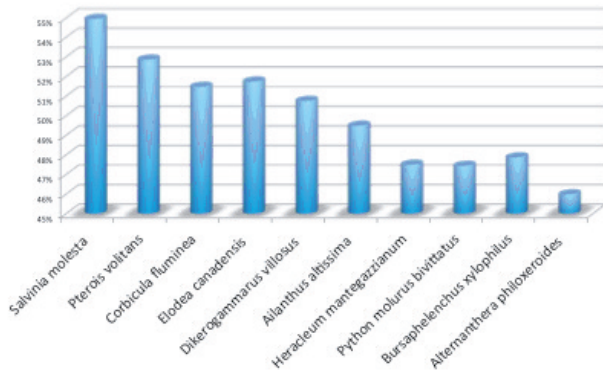
- *Salvinia molesta* is a floating aquatic fern from South America that thrives in slow-moving, nutrient-rich, warm freshwater. It can form dense vegetation mats that reduce water-flow and lower light and oxygen levels in the water. Following the same reasoning behind the development of the 100-list, this approach is not meant to be a precise selection of "the" worst but rather a rational selection of "some of the" worst, as it is difficult to classify objectively one species to be 'worse' than another. A few participants regretted the absence of one species or another, which reminds us that there are still many species that could be considered in such a list.

This list of ten invasive alien species was proposed to the community of invasion biologists for them to vote and collectively select the species that would best serve the community as the latest and 100th representative of the "100 of the World's Worst Invasive Alien Species" list. To participate, experts simply had to visit a dedicated web site (www.ese.u-psud.fr/epc/conservation/pages/The100th/index.html) and score each species. The selection was made according to the Condorcet Vote procedure. This procedure selects the candidate (here a species) that would win by majority rule in all pairings against the other candidates. It requires only one round of voting. Because it is somewhat akin to the rock/paper/scissors game, a candidate can be, counter-intuitively, ranked higher than the next in terms of cumulated preferences, simply because it would win a pairwise comparison.

Eventually, over 650 valid votes were registered from 64 countries. The result showed a preference for the giant aquatic fern, *Salvinia molesta* (Fig. 1), followed by the red lionfish. The selection of a plant is interesting, especially since this is not the focal taxon of the majority of experts in biological invasions. This fact shows first that the community did not tend strongly to vote for the species they work on, or even a taxonomically close species. Second, this choice will help highlight that invasive plants are often very problematic, even if they are generally less publicised than animal invaders.

The fact that the 100-list illustrates "some of the" worst implies that countless species out of this list are also highly problematic and need to be monitored and controlled. It is understandable that managers and policy makers would emphasize

Figure 2. Result of the vote by the invasion biologist community, putting the giant salvinia first of the ten candidates to integrate the IUCN list of the “100 of the world’s worst alien invasive species”.



membership in this list as an indication of high level of risk and/or damage and as an argument to obtain action/funding. However, the opposite is not true: species not on that list should also be given high levels of commitment and responsiveness. In fact, it is our hope that our community will be able to add new species to this list regularly, as this would mean that species currently on the list are progressively removed from it as they are eradicated from their entire invasive range. Lastly, this original endeavour shows that invasion biologists, who encompass scientists, managers, policy makers and other types of experts, are forming a reactive and committed community. Over 650 specialists over the world responded rapidly and efficiently, collectively promoting the highlighting of a problematic species for which, in the end, only a handful had direct professional interest.

It is hoped that the addition of Giant Salvinia to the list will help increasing awareness on the severe impacts caused by biological invasions worldwide.

The full list of the World’s Worst Invasive Species can be viewed on the ISSG website.

The review was featured in an article published in Nature (Luque GM, Bellard C, Bertelsmeier C, Bonnauud E, Genovesi P, Simberloff D, Courchamp, F (2013) Alien species: Monster fern makes IUCN invader list. Nature, 498, 37)

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Giant Water Fern (*Salvinia molesta*)

GEOFFREY HOWARD IUCN

The Giant Water Fern is an unattached floating plant which originates from tropical South America but is now widespread and usually invasive in lakes, rivers and wetlands around the tropical world. The plants are small floating units of several tightly packed “leaves” along a horizontal stem with modified leaves (rhizoids) hanging down below the water - often with empty sporocarps. The exposed surface of the plant is covered in very special minute hairs which trap air bubbles and so keep the plant both afloat and upright no matter the disturbance. It is unique amongst the several species of *Salvinia* in being sterile (i.e. producing no viable spores) and so spreading by small plant fragments which are moved along its invasion pathways by water currents, winds, water-birds, other animals and people (with their boats, fishing gear, vehicles, etc.). Once established on a water body, salvinia grows very quickly in warm climates with adequate dissolved nutrients and forms mats which can double their area in less than three days - a major attribute that facilitates its powers of invasion. Beneath such mats, light is minimal and oxygen can become depleted, with dramatic negative effects on submerged animals and plants and, of course, fisheries. Such fast growth can also result in significant accumulation of dead water fern plants which pollute stagnant waters and block water channels, irrigation canals and water transport. If a salvinia mat persists, it can become a platform for other aquatic vegetation to grow upon and so form floating islands (or “sudd”) which often adds further complications to an already existing invasion.

Prevention of new infestations of giant water fern establishing in areas where it is already abundant is virtually impossible, but new growths may not become invasive if water nutrient levels are low and if the water temperature is not warm (regularly below 15°C). The plants can be cleared manually or with mechanical harvesting equipment - but new plants will grow if this is not repeated often and re-invasion from plant fragments is likely. Herbicides can be used to clear an infestation of salvinia but this is always risky in freshwaters where non-target organisms abound. Fortunately there is a very effective biological control organism widely in use and widely available - a small herbivorous weevil, *Cyrtobagous salviniae* which has been shown to be host-specific and so no risk to other vegetation; like its food plant, it does not thrive when water temperatures are low and so has little impact in cold climates.





Managing the impacts of feral camels in Australia

QUENTIN HART AND GLENN EDWARDS

The one-humped camel (*Camelus dromedarius*) is an exotic species in Australia, with their introduction in the 1840s for exploration and other transport purposes. The widespread establishment of a feral population is likely to have begun in the 1920s with the ongoing release of domestic camels associated with the increased use of motor vehicles. However, acknowledgment of feral camels as an introduced species of concern in Australia has been relatively recent: although individual landholders have no doubt experienced feral camel impacts for decades, it wasn't until detailed monitoring of camel browsing in the early 1990s and aerial survey work in the 2000s that the extent of the growing problem became apparent at a national level. A stakeholder workshop was held in 2005, with key stakeholders being landholders, government agencies, animal welfare interests and the commercial use industry. This workshop led to a three-year investigation of the feral camel population and impacts which in turn led to the current Australian Feral Camel Management Project, managed by Ninti One Ltd with support from the Australian Government and a large number of project partners. An overarching national strategy document has also been developed, the National Feral Camel Action Plan. It is not considered to be technically feasible or economically sensible to attempt to eradicate a widespread established exotic species such as feral camels and therefore the strategy is based on ongoing management to reduce and maintain densities at levels where damage is acceptable to the majority of stakeholders.

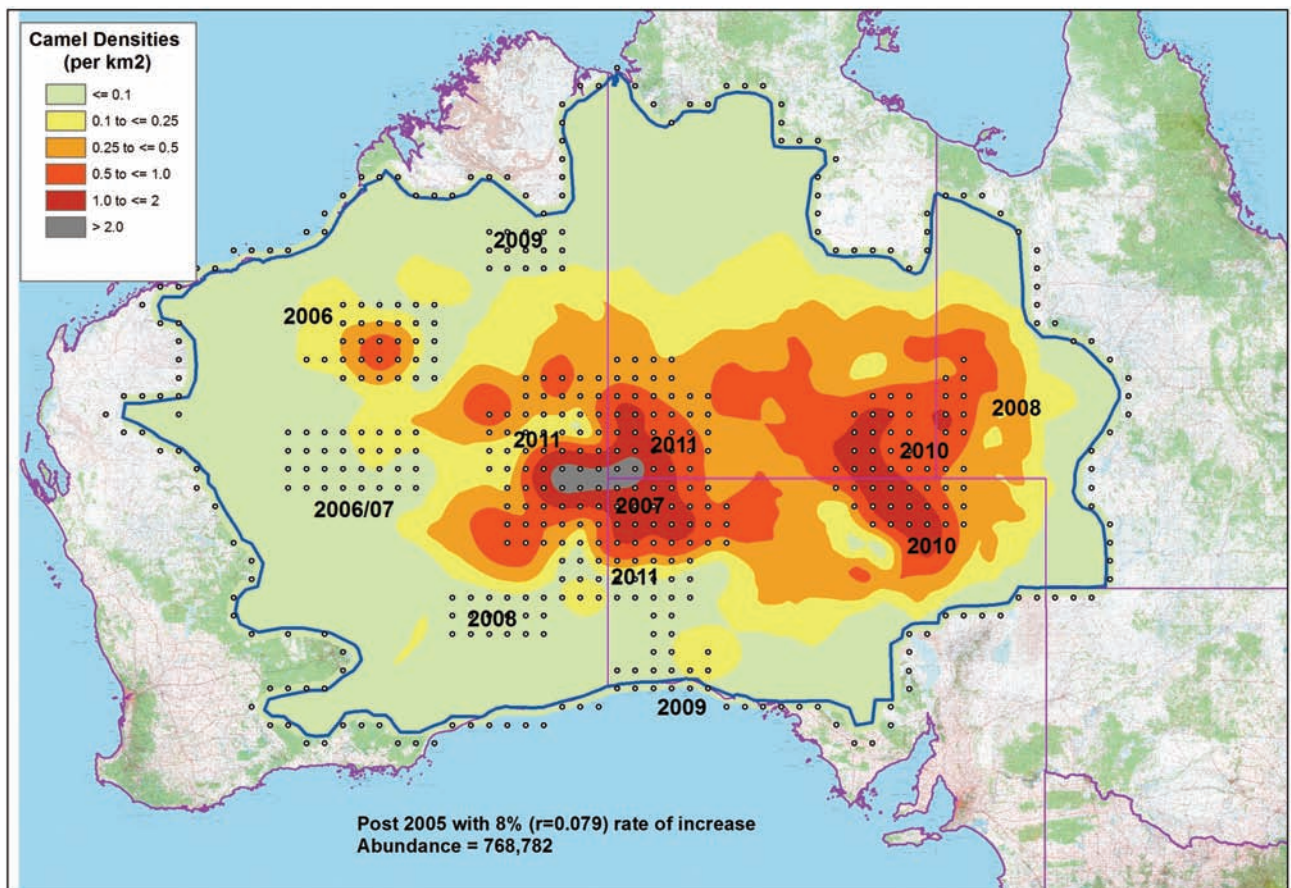


Figure 1. 2011 feral camel density map extrapolated from aerial survey data since 2006, that suggests a population of around 750,000. This map will be updated with 2013 aerial survey data.

Establishing the information base

The work of Döriges and Heucke (1995, 2003) continues to be instrumental in guiding feral camel research and management in Australia. It provided baseline information on which plant species were most likely to be affected by feral camel browsing in central Australia and this work has guided environmental impact monitoring under the current Australian Feral Camel Management Project (AFCMP). It also provided information on feral camel reproduction, movements and behaviour that has helped develop current population models and management strategies.

Estimating the population of feral camels in Australia is problematic due to the huge distribution of the species (over three million square kilometres), the high cost of aerial surveys and the fact that feral camels are highly mobile and congregate and disperse according to seasonal conditions. The

current population estimate is around 750,000 animals; however, the more relevant figure is the feral camel density in a particular region at a particular time and what this means for impact.

The Desert Knowledge Cooperative Research Centre (DKCRC), a research, development and extension collaboration managed by Ninti One Ltd, received funding from the Australian Government to undertake a three-year (2005-2008) research project to assess feral camel population dynamics, impacts, stakeholder views and management strategies. The subsequent report (Edwards et al. 2008) recommended a long-term density target of 0.1-0.2 feral camels per square kilometre in the core higher density feral camel areas (see Figure 1).

The comprehensiveness of the DKCRC report was instrumental in securing further Australian Government funding for the \$19 million, four-year AFCMP, commencing in 2009-10, with a targeted objective of achieving density targets at particular environmental sites (see Figure 2).

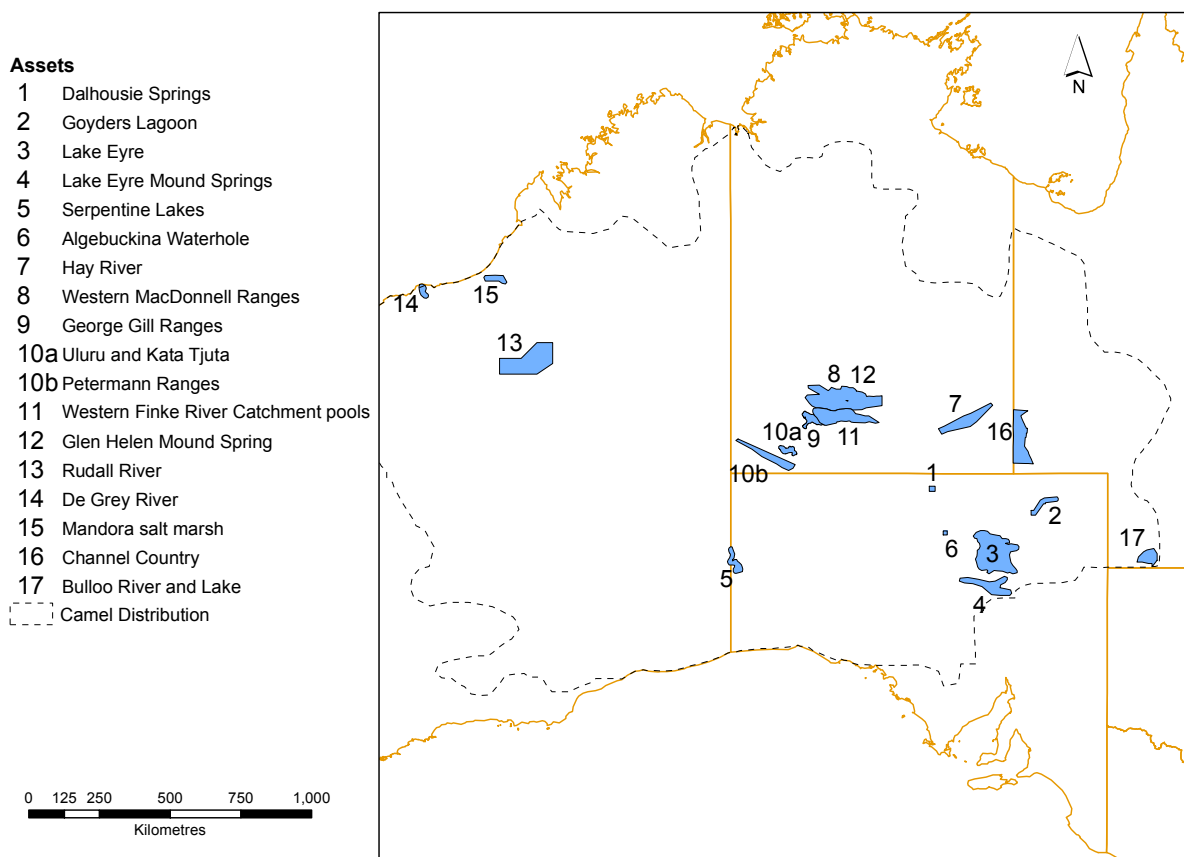


Figure 2. The 18 environmental sites that the AFCMP has been charged with protecting from unacceptable levels of feral camel damage.





Figure 3. Large mob of feral camels in the Simpson Desert. Photo: R.Sleep

The management challenge

The AFCMP is an ambitious invasive species management project that:

- covers over 3 million square kilometres and hundreds of landholders
- involves 20 project partners
- is the first Australian project to manage a terrestrial vertebrate pest at this scale, using conventional control techniques, without the legislative support available to programs such as the Brucellosis and Tuberculosis Eradication Campaign.

Figure 4. The ultimate result of feral camel congregations: denuded landscape, depleted water sources and dying animals. Photo: R.Bugg



The project is working with a large number of partners and stakeholders to reduce the impact of feral camels on desert ecosystems, the pastoral industry, remote Aboriginal communities and public safety.

The project's primary focus is biodiversity protection at nominated environmental sites, which are typically desert wetlands that have an important role as biodiversity refugia as well as often being sites of cultural significance to Aboriginal people. Feral camels also damage pastoral infrastructure (fences and waterpoints) and pose a safety threat on roads, airstrips and in the communities themselves. Remote communities are heavily dependent on light aircraft access, and congregations of feral camels around airstrips threaten this access. During prolonged dry periods, mobs of feral camels may move into communities in their desperation for water.

Project measures include achievement of feral camel density targets at nominated environmental sites and other parameters such as wetland condition, vegetation browse damage and stakeholder views.

The AFCMP has made substantial progress, largely based on an early realisation of the need for comprehensive collaboration processes due to the diverse range of land tenures (Aboriginal, conservation estate, pastoral and unallocated government

Figure 5. Feral camels are the only animal in the Australian landscape capable of producing such high browse lines.
Photo: D.Ferguson



land) across which feral camels roam and the diverse stakeholder interests, including commercial use. The comprehensive governance structure of the project allows for regular interaction between project partners, land managers, broader stakeholders (e.g. commercial use and animal welfare interests) and technical and operational personnel. This facilitates communication, policy development, risk management and adaptive management – the latter aspect being particularly important in responding to adverse seasonal conditions (e.g. wet weather, which disperses feral camel mobs and makes management more difficult and less cost-effective).

The AFCMP is engaging with two themes that were highlighted at the 2010 50th Ecological Society of Australia (www.ecolloc.org.au) conference: the need to develop workable solutions to biodiversity issues based on informed sta-

keholder preferences and learning by doing; and combining Aboriginal and Western ecological knowledge for land management solutions. A significant proportion of the feral camel population is on Aboriginal lands and this requires comprehensive management consent processes which are different in each jurisdiction.

Although the focus of the AFCMP is management, we are also improving knowledge of feral camel movements, demographics, impacts and management, as well as better understanding what is involved in coordinating a national landholder engagement and environmental management project.

Commercial use

The AFCMP supports the development of a strong, viable commercial use industry (which is currently predominantly based on mustering to process meat for human consumption) that provides long-term benefits and employment for remote communities, provided feral camel damage is managed to acceptable levels. As part of an integrated approach to feral camel management, the project is supporting commercial use on Anangu Pitjantjatjara Yankunytjatjara (South Australia), Ngaanyatjarra (Western Australia) and Central Land Council (Northern Territory) lands. Around 20 per cent of feral camels removed under the project are through commercial use.



Figure 6. In their search for water, mobs of feral camels can have dramatic impacts on rangelands infrastructure.
Photo: Ninti One Ltd



Figure 7. Motion-activated cameras are providing information on which native animals are dependent on the scarce desert wetlands that feral camels are destroying.



The commercial use industry is represented on the AFCMP Steering Committee through the Australian Camel Industry Association. In addition, Ninti One has had numerous discussions with commercial use proponents about project activities and how they can engage with landholders. The commercial use industry will need to continue to effectively engage with landholders and demonstrate that they can remove large numbers of feral camels in a timely manner.

Some parts of Australia will remain too remote for commercial use to be viable, so there will always be a role for aerial culling to address the concerns of landholders and land management agencies about feral camel impacts.

Animal welfare

Animal welfare should be a key consideration for all invasive vertebrate management programs. AFCMP activities are conducted according to detailed Standard Operating Procedures to ensure the humaneness of aerial culling, ground culling and commercial use. There is independent veterinary verification of performance against these procedures and the Royal Society for the Protection of Animals (RSPCA) has oversight of this process. Apart from ensuring that individual animals are removed humanely, there are several other important RSPCA principles (RSPCA Policy E02 Management of wild animals, available at www.rspca.org.au) that the AFCMP is taking account of:

- Invasive vertebrate management should be justified in

terms of defined impacts and clear management objectives – the AFCMP is based on a comprehensive review of feral camel impacts (Edwards et al. 2008) and has specific objectives in terms of density targets at particular sites. The project has a comprehensive Monitoring, Evaluation, Reporting and Improvement (MERI) component.

- Management efforts should be maintained to avoid the recovery of the invasive vertebrate population – the AFCMP involves a species with an inherently low rate of increase (probably around 5-10% population increase per year, depending on seasonal conditions) which will help ensure that density reductions can be maintained. Capacity building is an important component of the AFCMP to ensure that good management skills are in place throughout the feral camel distribution for sustained removal effort.

AFCMP achievements

Key achievements of the project to date include:

Governance and landholder engagement

- established a comprehensive governance structure to ensure regular input from the 20 project partners and broader stakeholders
- established landholder consent for commercial and/or non-commercial feral camel removal over all priority areas for feral camel management

Feral camel removal operations

- implemented rigorous Standard Operating Procedures for aerial culling, ground culling and mustering, with independent oversight of same, confirming a high standard of animal welfare
- supported the development of an aerial culling Decision Support System to help improve the efficiency of removal operations; aerial culling operations have been highly efficient with a typical direct cost of around \$20-50 per head
- supported the commercial use industry by linking landholders with commercial interests, training and minor infrastructure
- removed over 150,000 feral camels and on track to achieve density targets at most sites despite being hindered by wet weather in 2010-11

Capacity building

- enhanced the capacity of landholders and land management agencies to undertake culling and commercial use operations into the future
- around 500 Aboriginal people have been trained in monitoring and managing feral camel impacts

Improved knowledge

- improved knowledge of feral camel distribution, density and movements through aerial survey, aerial cull GPS records and satellite tracking
- established five intensive environmental monitoring sites across Australia
- around one million motion-activated camera images have been taken of the animals that depend on scarce desert water sources – one preliminary finding is that feral camels seem to be changing the drinking patterns of dingoes which is in turn affecting the drinking behaviour of prey species
- around 120 vegetation sites are being monitored and some of these are indicating that the interaction of fire and browse damage by feral camels and other herbivores is threatening the local survival of some species.

Beyond the AFCMP

The AFCMP currently ends on 31 December 2013 and should be regarded as only the first step in ongoing national coordination of feral camel management. The extreme mobility of feral camels requires management across jurisdictions; not just across land tenure. There is a risk of regression in many

AFCMP achievements if commitment to and resourcing of feral camel management reverts to historic levels.

The final AFCMP aerial surveys will provide improved information on the background rate of feral camel population increase and a better understanding of the level of removal required to meet long-term density targets (ideally, less than 0.1 per square kilometre across most of the feral camel distribution).

The systems and partnerships developed through the AFCMP will support long-term feral camel management and we believe the project offers a useful model for other cross-tenure and cross-jurisdictional environmental management projects.

References and further reading

Australian Feral Camel Management Project Website: www.feralcamels.com.au

Dörge B and Heucke J (1995) Ecology, social organisation and behaviour of the feral dromedary Camelus dromedaries (L.1758) in central Australia. Unpublished report (translated from two PhD theses, submitted 1995). University of Braunschweig, Braunschweig, Germany.

Dörge B and Heucke J (2003) Demonstration of ecologically sustainable management of camels on Aboriginal and pastoral land. Final report on NHT project no. 200046. Natural Heritage Trust, Canberra, Australia.

Edwards GP, Zeng B, Saalfeld WK, Vaarzon-Morel P and McGregor M (Eds)(2008) Managing the impacts of feral camels in Australia: a new way of doing business. DKCRC Report 47. Desert Knowledge Cooperative Research Centre, Alice Springs, Australia.

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Goats eradicated from Aldabra Atoll

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On 3rd August 2012, history was made for Aldabra Atoll, the Seychelles and for international conservation, when the last feral goat (*Capra hircus*) on Aldabra was shot.

The shooting of the last goat marked the end of eradication efforts which had lasted for more than 25 years, and an intensive programme for the previous 5 years. Several approaches were applied across the years. The most successful, and the key to eliminating this species from Aldabra, was the hormone-supplemented sterile Judas-goat technique, pioneered by Taylor et al. in the Hawaiian islands (Taylor & Katahira, 1988).

The introduction of feral goats to islands worldwide has caused widespread ecosystem degradation and biodiversity loss (Taylor & Katahira, 1988, Campbell et al, 2007, Cruz et al, 2009). On Aldabra Atoll, goats were introduced before 1878 and within 50 years there were reports of thousands on the atoll (Stoddart, 1981). When the Royal Society arrived in 1967, goats were present on all four main islands of Aldabra (Grande Terre, Picard, Malabar and Polymnie) as well as a smaller lagoon island (Ile Esprit) (Stoddart, 1981). Viewed as a major threat to Aldabra's endemic biodiversity, elimination of the goats rapidly became a priority for the Seychelles Islands Foundation (SIF), the management authority of Aldabra (Fig.1).

SIF came into being under legal decree in 1979 with a specific mandate to manage and protect Aldabra. Aldabra became a UNESCO World Heritage site in 1982 and, several years later, SIF was also assigned responsibility for the Seychelles' second UNESCO World Heritage Site, the Vallée de Mai. SIF has been responsible for both sites since 1989.

The first targeted control programme initiated by SIF was in 1987–1988. Coblenz et al. (1990) showed that goats were altering plant species composition and slowing the regeneration of natural vegetation as well as reducing shade cover and forage for giant tortoises (*Aldabrachelys gigantea*). During this period, 883 goats were eliminated by shooting: 814 from the largest island of Grand Terre, 61 from the second largest island of Malabar and eight from Aldabra's third largest island, Picard.

Then, in 1988, an eradication programme using the Judas goat method was applied for the first time. This method was developed and first used by Taylor and Katahira (1988) and uses radio-transmitters attached to leather collars, which are then fitted to goats (Fig.2). These goats are known as 'Judas' goats, which are then tracked and monitored. The method exploits the social and gregarious nature of feral goats. Goats will associate closely with each other and Judas goats in the group

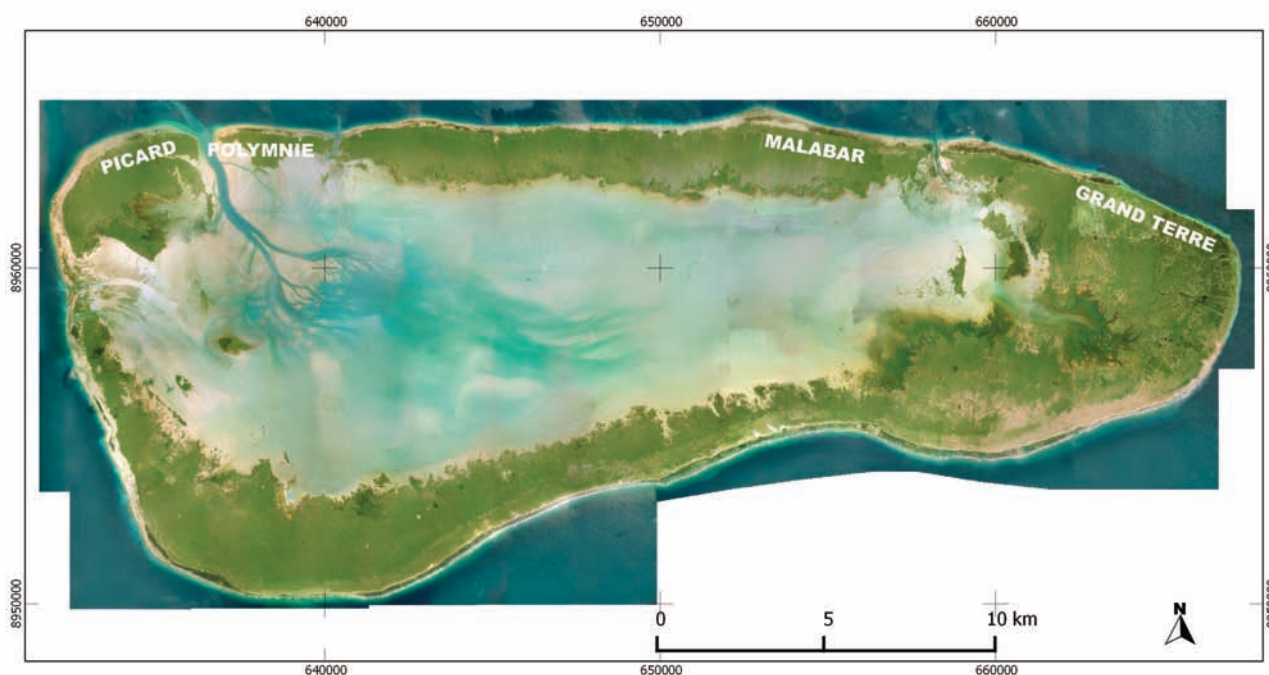


Figure 1 - Map of Aldabra Atoll. Copyright: SIF



Figure 2 - Judas goat fitted with radio telemetry collar
Photo: Rainer von Brandis

can be tracked to allow non-Judas associates to be eliminated (Taylor and Katahira, 1988; Campbell, 2007). The Judas goats themselves are not shot and will go on to associate with other goats so the process is repeated. Using this method, 28 Judas goats were created and by 1995, goats had been eradicated from all islands of Aldabra except Grand Terre (Fig. 1), where it was estimated that 84 remained (Rainbolt & Co-blentz, 1999). A follow-up effort was then conducted in 1997, when a further 106 goats were culled on Grande Terre (SIF unpublished data) but not eliminated. Between 2000 and 2005, approximately 250 goats were shot on a non-targeted opportunistic basis using conventional hunting methods (von Brandis, 2007).

In 2006, planning began for a concerted effort to complete the eradication programme using recent advances in Judas goat methodology (von Brandis, 2007). At that time, it was estimated that approx. 100–200 goats remained on eastern Grand Terre (von Brandis, 2007) and there were not thought to be goats outside this area. After substantial planning and preparation, the field programme began its intensive 5-month period in August 2007 with a team of four staff, including the project manager, two additional hunters and a veterinarian. Selected male and female Judas goats were immobilised with tranquiliser darts and then prepared for active Judas goat service following Campbell et al.'s (2004) method. This includes sterilisation of both sexes, hormone treatments of females to induce abortions in pregnant females and oestrus in non-pregnant females, and additional hormone implants of females to increase oestrus by 6–16 times. Radio-telemetry collars with a battery life of 2–3 years and a range of 1–10 km were also fitted (Campbell et al, 2005). Judas goats were woken up



Figure 3 - SIF Aldabra rangers learning to use telemetry equipment.
Photo: SIF



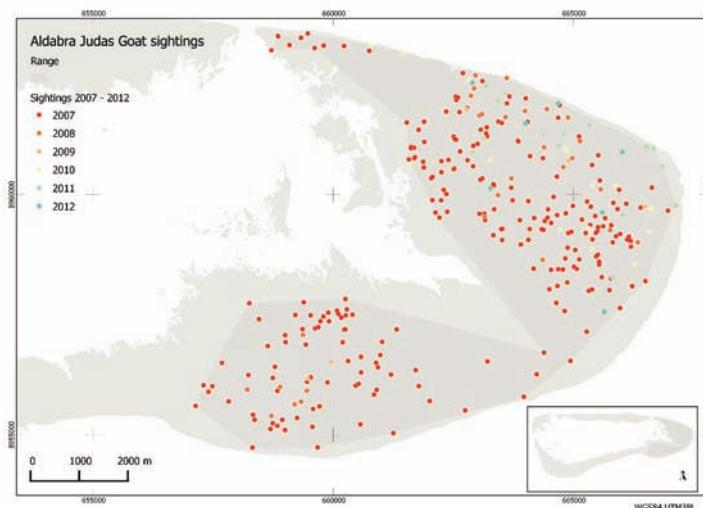


Figure 4 - Map of Judas goat range on Grande Terre 2007 - 2012

with a reversal agent and monitored for several days until they were behaving normally and associating with other goats again.

Associations of Judas goats with other Judas goats were split up by recapture and relocation or elimination of one of the pair. By the end of the intensive period, 202 more goats (or almost equal sex ratio) had been shot by the eradication team and six Judas goats remained for follow-up monitoring (von Brandis, 2007). The home range of the Judas goats had increased substantially in size as the goat population reduced (von Brandis, 2007). Of the eliminated goats, 49% were below the age of 15 months, indicating that the population had been in a state of sharp increase (von Brandis, 2007).

With the intensive Judas goat establishment and hunting programme drawing to a close, the importance of monitoring and continued surveillance was emphasised. One vital part of the intensive programme was to train several local SIF staff from the Aldabra research team in the use of telemetry gear and tracking. It was proposed for SIF staff to monitor the Judas goats for 2 years on a monthly basis since eradication was not possible to confirm before completion of the monitoring programme. The aim of the monitoring was to locate any remaining associate goats after the end of the main eradication effort as it was expected that there were still some non-Judas goats present on Aldabra.

Although a two year period of monitoring effort was stipula-

ted to ensure completion of the eradication, the remaining six Judas goats were actively monitored by SIF staff on a monthly basis for more than four years following the end of the intensive hunting effort (from late 2007 until early 2012). Staff went on monthly 3-5 day long field trips to Eastern Grand Terre to track the Judas goats and eliminate further associate goats, as well as searching other areas for signs of goats. From the end of the hunting phase in December 2007 to the end of the eradication in 2012, a further 21 goats (excluding Judas goats) were shot by the team with the majority (17) shot in 2008.

One complication was the draining of the battery life of all Judas goat radio-transmitters throughout 2009.

It had been anticipated that the eradication would have been completed by this point but with goats still being shot, albeit at a low level, it became essential to fit new collars in order to continue the monitoring programme. Re-collaring requires additional skills in wildlife darting, so an external short-term consultant was recruited to initiate this effort and train staff in darting and processing of darted goats. This was successful and by October 2010, four Judas goats had received new collars.

The last two non-Judas goats were shot in March 2010 (Currie, 2010). The Judas goats continued to be monitored monthly and in 2011, in addition to the monthly monitoring trips, on-foot searches of areas other than the Judas-goat frequented region were undertaken to check for signs of goats. No signs were found. In September 2011, one of the two female Judas goats was intentionally shot to stimulate searching behaviour in the males who had to become attached to her.

In December 2011, after seeing no associate goat for 1 year and 9 months, an aerial survey was conducted by the Indian navy. Their main objective was to scan the eastern Grand Terre region and assess whether more than five collared goats were present (van de Crommenacker, 2011). The helicopter survey identified and photographed four goats, all of which were later identified as Judas goats.

With the helicopter survey complete and no sightings of non-Judas animals for almost 2 years, it was decided in early 2012 that it would be necessary to give the eradication the final stamp of approval via external verification. Thanks to funding from the European Union for an invasive alien species project,

two consultants were hired to eliminate all but one of the remaining four Judas goats and to cover Grand Terre on foot searching for signs of goats (Fig. 4). The consultants stayed for a total of 9 weeks on Aldabra from January to March 2012 and covered more than 1000 km on foot. They found no signs of goats other than those linked to the Judas goats. Three of the four remaining Judas goats were then shot to remove confusing signs of goat presence, and the last goat, J8 (because it had been the most effective Judas individual), was left alive, and then monitored 3 months later to determine whether he had managed to seek out any other animals. In June and July 2012 J8 was tracked and it was confirmed that it was alone, so the decision was taken to eliminate it as the last goat on Aldabra. Finally, on 3rd August 2012, J8 was tracked and shot, marking the end of feral goat inhabitation on Aldabra and the completion of an eradication attempt that had lasted for more than a quarter of a century.

Conclusions and lessons learned

A total of 2,344 goats were shot over the 25-year period. This success has been an important achievement for the conservation of Aldabra but many lessons have been learnt in the process, which can be summed up as follows:

- Judas goat techniques using radio transmitting technology have been an extremely effective tool to remove feral goats from Aldabra Atoll.
- The programme has been expensive, long lasting, and faced many logistical challenges owing to the remoteness of Aldabra
- The success stemmed from a collaborative group effort, which involved many SIF staff (from all Aldabra staff on the ground to administration staff in the office) at various levels, including, trackers, hunters, darting, field skills, logistical arrangements, tactical strategy and project coordination in addition to external consultants.
- Detailed protocols, in field observation data, and reports play an important role in documenting eradication, and providing information driving strategy and management
- In field, high quality, on-the-job training of local staff has been an essential component of the project. Such a long-term project can only be sustained and afforded when in-house and local staff are present and dedicated to maintain

the effort

- The relatively high staff turnover resulted in more local staff being trained and participating in this successful project
- Attention to detail and forward planning is essential – in our case, the batteries of the radio transmitters could have run flat, resulting in the loss of the Judas goat advantage in the field. If this detail was missed, or if we were unable to locate the Judas Goat in time success may have been harder to achieve. We were lucky that this was not the case.
- Early preparation and expectation of problems is essential, especially when dealing with firearms and other sensitive equipment such as telemetry gear and darting items.
- Pre-eradication surveys of the vegetation and other aspects of the biodiversity in goat-invaded areas would have been very useful in assessing the impacts post-eradication
- Funding should be sought at a later stage to support final completion of the eradication.
- Bringing the eradication to an end took longer than expected, but external verification by several methods (aerial helicopter survey, intensive on-foot search) helped to successfully close the project and confirm its success.
- Most importantly, prioritisation and commitment by the organisation(s) involved has been the key factor in ensuring the success of this eradication by ensuring staff and equipment resources, as well as full logistical support, are provided.

Acknowledgements

We would like to acknowledge all of the SIF staff, volunteers and consultants who have played a role in this epic achievement and conservation milestone for Aldabra. It would be impossible to mention you all by name but in particular we would like to thank:

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References

- Bergeson, M. (1997). *Goat eradication Phase 3 –Final report*. Seychelles Islands Foundation, unpublished report.
- von Brandis, R. (2007). *The Aldabra Goat Eradication Programme (2007): Final Report*. Seychelles Islands Foundation, unpublished report.
- Campbell, K.J., Baxter, G.S., Murray, P.J., Coblenz, B.E., Donlan, C.J., and Carrion, V. (2005). *Increasing the efficacy of Judas goats by sterilisation and pregnancy termination*. *Wildl. Res.* 32: 737–743.
- Campbell, K., Donlan, C.J., Cruz, F., and Carrion, V. (2004). *Eradication of feral goats Capra hircus from Pinta Island, Galápagos, Ecuador*. *Oryx* 38: 328–333.
- Campbell, K.J., Baxter, G.S., Murray, P.J., Coblenz, B.E., and Donlan, C.J. (2007). *Development of a prolonged estrus effect for use in Judas goats*. *Appl. An. Behav. Sci.* 102: 12–23.
- Coblenz, B.E., Van Vuuren, D., and Main, M.B. (1990). *Control of feral goats on Aldabra*. *Atoll Research Bulletin* 337: 1–13
- van de Crommenacker, J. (2011). *Aldabra Annual Report 2011*. Seychelles Islands Foundation, unpublished data.
- Cruz, F., Carrion, V., Campbell, K.J., Lavoie, C., and Donlan, C.J. (2009). *Bio-economics of large-scale eradication of feral goats from Santiago Island, Galápagos*. *J. Wildl. Manage.* 73: 191–200.
- Currie, J. (2010). *Aldabra Annual Report 2010*. Seychelles Islands Foundation, unpublished data.
- Rainbolt, R.E., and Coblenz, B.E. (1999). *Restoration of insular ecosystems: control of feral goats on Aldabra Atoll, Republic of Seychelles*. *Biological Invasions*, 1: 363–375.
- Stoddart, D.R. (1981). *History of goats in the Aldabra archipelago*. *Atoll Research Bulletin* 255: 23-26
- Taylor, D. and Katahira, L. (1988). *Radio telemetry as an aid in eradicating remnant feral goats*. *Wildlife Society Bulletin*, 16:297-299

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The practicalities of eradicating an extremely invasive cactus: Hudson pear *Cylindropuntia rosea* in the Valencia region (East Spain)

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Opuntioids are a group of plants included in the Cactaceae family originating from the Americas. Within this group, the genus *Cylindropuntia* comprises taxa with detachable stem segments and barbed spines. Some of these taxa, such as *C. fulgida*, *C. tunicata* and *C. rosea* show invasive traits in South Africa, Australia, Chile and Spain (Elorza et al. 2004; Henderson, 2012; Johnson et al. 2009; Squeo et al. 2008). Control is difficult, not only because of their spiny nature but also due to their excellent dispersal abilities (by means of stem fragments) and the cryptic nature of small plants, which allows them to blend into the landscape while building up large populations. Notwithstanding this, there is a lack of awareness of the risk posed by these species and invasive plant compendiums often overlook them (with some notable exceptions,

like in the case of CABI ISC, see <http://www.cabi.org/isc/>). Epitomising the abilities described above, Hudson pear *Cylindropuntia rosea* (a native of central Mexico) could well be considered one of the most invasive cactus species of dry areas of the world. In the Valencia region (East Spain) this shrubby cactus (Fig.1) behaves as an extremely invasive weed, as it also does in New South Wales, Australia (Anon. 2012; Johnson et al. 2009). Vectors contributing to its dispersal have been cattle at a local scale and human mediated dispersal at a larger scale. Aware of its invasive potential, the regional government of Valencia has set about a plan to completely eradicate the species. What follows is an account of its impacts, of the strategy undertaken for its control and of the encouraging results attained thus far.



Figure 1. Large –over 1m in height– specimens of *C. rosea* colonising suburban areas. Long whitish spines, purple flowers and a large shrubby multi-branched habit are characteristic of the species. Photo: Josep Enric Oltra.





Figure 2. Dense infestations of *C. rosea*, such as these in the largest colonised natural area of the Valencia region, can hinder recreational use and change the visual appearance of landscapes. Photo: Vicente Deltoro

Impacts

Colonisation of natural habitats by Hudson pear can affect biodiversity. We have witnessed direct competition for habitat with endangered plants, like *Commicarpus africanus* or ironwort (*Sideritis glauca*) included in Annex II of the Habitat's Directive. In both instances, Hudson pear occupies the rock crevices where these plants grow, presumably hindering their population dynamics. Hudson pear also competes with rare vegetation types, such as pre-desert deciduous scrub formations, and becomes the dominant vegetation, probably as a result of high water-use efficiency conferred by its crassulacean acid metabolism, and a complete lack of herbivore pressure. We have even found wild animals, such as weasels or squirrels, impaled among the segments of the plants.

Large infestations (Fig. 2) of Hudson pear degrade the visual appearance of the landscape, reducing its appeal for nature-based tourism. Most importantly, due to the dangers it poses to man on account of its vicious spines, the weed has the potential to hinder recreational use of the territory and its social values. Still, the impacts described above are restricted to two areas in the Valencia region, where the weed grows in dense colonies. Scattered populations of Hudson pear are also found across the territory in suburban areas.

Risks

The decision to undertake control of the species in Valencia was prompted more by the possible impacts of the cactus than by known impacts. On one hand, field observations revealed active expansion of existing populations and, more importantly, the results of a risk analysis stressed that the potential impacts could be high owing to the following factors:

i) It behaves as a weed in territories with climatic similarities to the Valencia region, for example, parts of Australia (Anon. 2012). In these regions, as in Valencia, the plant is not inhibited by limiting conditions, such as a combination of intense heat and drought. In fact, most of the infestations in the Valencia region occur in dry areas (below 300mm) with mild mean annual minimum temperatures and warm annual temperatures. If these factors are combined the area that could be impacted by Hudson pear could amount to 7.503 sq. km. Thus at least 32% of the Valencia region could be suitable for colonisation by the species (Fig. 3).

ii) Hudson pear is capable of rapid colonisation of an area and of long distance dispersal. Anecdotal evidence suggests that the weed has managed to reach its known distribution in Valencia after having been introduced some 40 years ago. Since then, the plant has managed to disperse to occupy 42 1x1 km square grid populations and to build up dense populations consisting of tens of thousands of specimens. Hudson pear has never been intentionally planted by any administration, as has been the case with other weeds, i.e. *Lantana*, *Cortaderia*, and to our knowledge it has never been sold in plant nurseries. This means that the plant has achieved its current distribution in Valencia with an exceptionally low propagule pressure.

The strategy: strict regulation, timely detection and early response

Aware of the risks posed by Hudson pear, the regional government of Valencia included the plant within Annex I of Decree 213/2009, through which measures for the control of this exotic species were approved. This meant the prohibition of trade, transport and introduction into the region, and that control measures should be undertaken. The Decree also established the creation of an alert network among the 242 forest wardens of the region, as well as training staff in the 22 regional natural parks to specifically detect invasive species in the field. The goal of this network was to detect invasions at an early stage.

In the case of Hudson pear, this alert network proved a pivotal component in its control. Within 2 years of the start of the

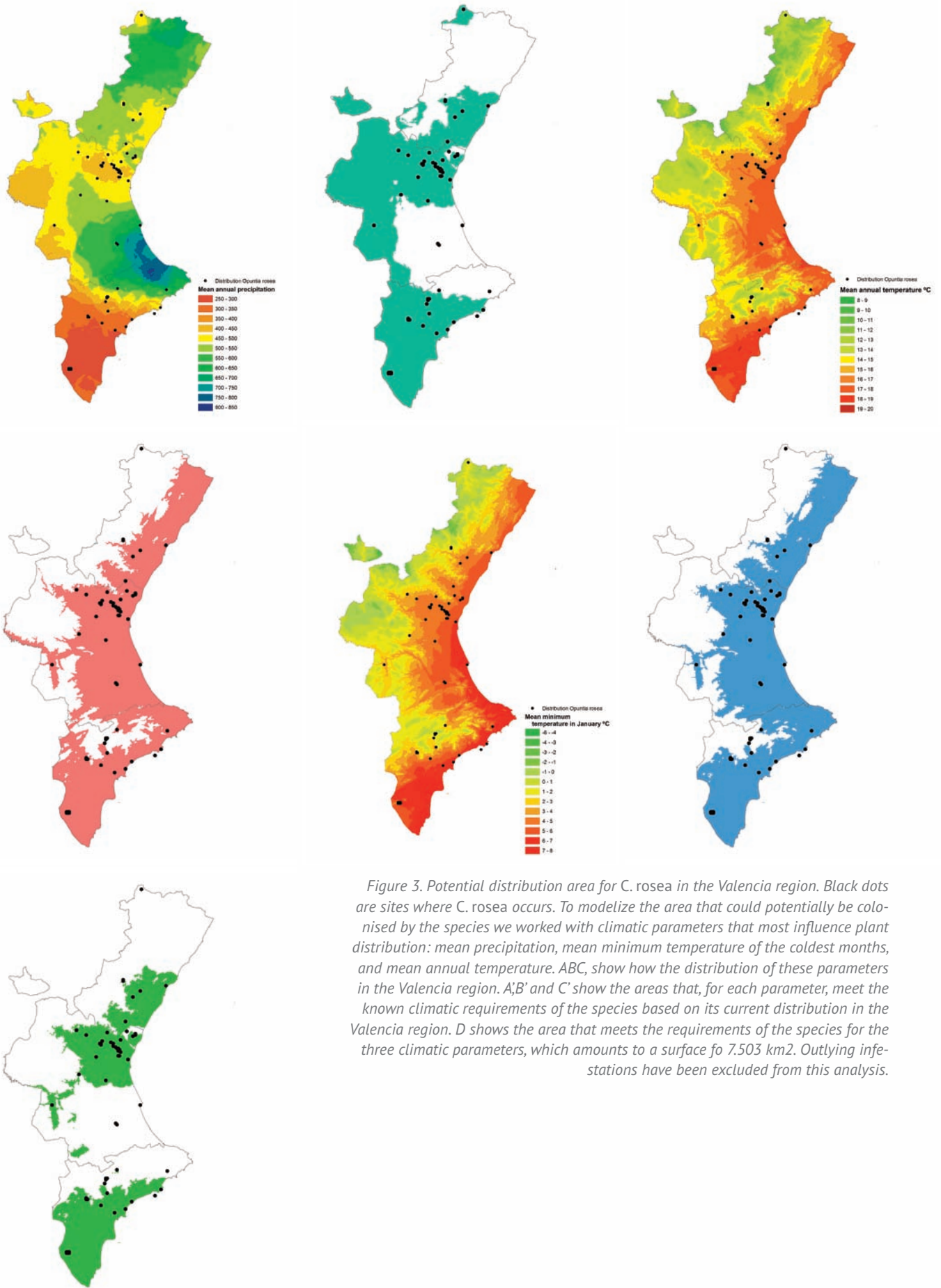


Figure 3. Potential distribution area for *C. rosea* in the Valencia region. Black dots are sites where *C. rosea* occurs. To modelize the area that could potentially be colonised by the species we worked with climatic parameters that most influence plant distribution: mean precipitation, mean minimum temperature of the coldest months, and mean annual temperature. ABC, show how the distribution of these parameters in the Valencia region. A',B' and C' show the areas that, for each parameter, meet the known climatic requirements of the species based on its current distribution in the Valencia region. D shows the area that meets the requirements of the species for the three climatic parameters, which amounts to a surface of 7.503 km². Outlying infestations have been excluded from this analysis.



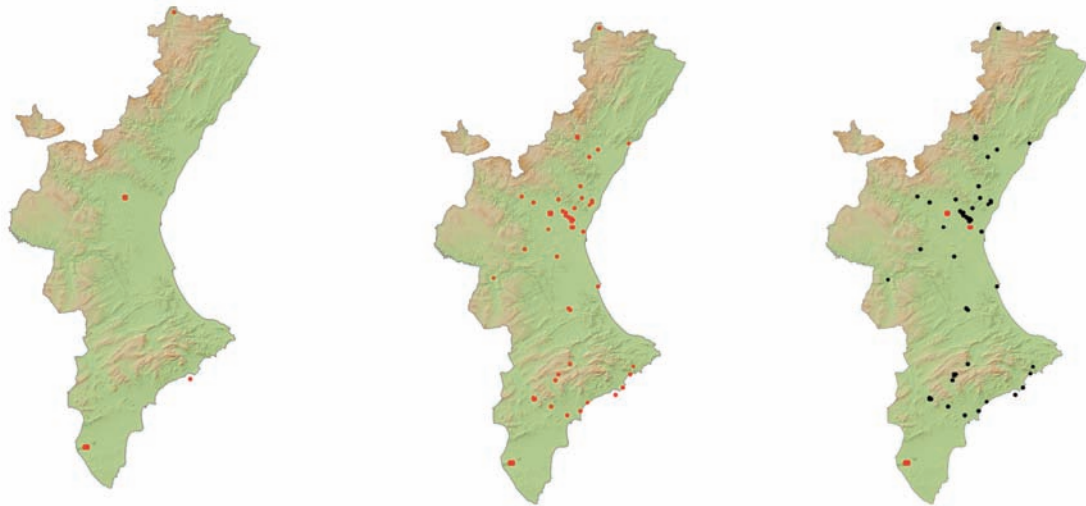


Figure 4: Evolution of knowledge of the distribution of *C. rosea* and progress of eradication works. Left: knowledge of distribution before the alert network was set up. Centre: distribution of the species after the alert network had contributed new locations. Right: Current status of eradication works. Black dots: eradicated populations; Red dots: existing populations. All small –but two– and medium-sized populations have been eliminated. The largest population, at the bottom, will have been completely eradicated by the end of 2013.

network, 38 new and previously unknown infestations were detected and mapped (Fig. 4). This completely changed the appreciation of the invasive potential of the species, since only four populations (2 very large and 2 small) were previously known.

Control work started in 2009 and focused primarily on scattered infestations to restrict the species expansion. All but two small –<100 ind.– and medium-sized –<1000 ind.– populations have been eradicated by six trained squads of four people who carry out biodiversity conservation work in a territory of 23.000 km² (Fig. 4). Altogether they have worked ap-

proximately 600 working days on the eradication. This works out to an average of 15 working days, or an investment of 2.600€. These results contrast starkly with the amount of labour and the budget required to eradicate the largest infestation: 945.000€ and 3,5 years of work by a squad of eight operators. At this site, anecdotal evidence suggests that the weed has been present for 40 years. During this period of time it has colonised with varying degrees of density aided by goat-herds. When the work ends in June this year it is estimated that 185 tonnes will have been extirpated manually, at a mean performance of 37,5kg each working day-1.



Figure 5. Procedure for manual eradication of *C. rosea*. Workers pull detached or cut fragments into containers with small rakes (A). Once free from segments the main stems are cut with saws on poles and the roots dug out (B, C). The area is meticulously cleaned. Photo: Vicente Deltoro.

Management options

The preferred control method for Hudson pear in the Valencia region has been manual eradication, however, in the case of large infestations on flat terrain, mechanical means have also been used. Manual eradication requires removal of the higher parts of the plant (Fig. 5) using saws on poles to prevent injury to operators. Detached fragments are harvested with hayforks and put into fibreglass or metal containers; plastic or rubber being unsuitable as spines will attach to the surface. Finally, the cleared area is examined for fragments and the plant is then uprooted. The plants are then transported to authorised residue managers where they are ground, dried and burnt.

Hudson pear infestations have also been eradicated by spraying them with Garlon GS and a spray oil at a concentration of 2%. Spraying with this mixture is 100% effective if done until drip-off occurs. In the case of large plants, re-treatment may be necessary as segments often escape untreated due to the intricate growth habit of the species, however, the addition of a dye to the spray mix helps to prevent this from happening. Spraying must be carried out during the active growing season (June, in our region) for increased efficiency. Visible symptoms of herbicide damage manifest slowly, and complete die-off might take 5 or 6 months. Chemical treatment is 15 times less expensive than manual eradication. Additionally, plant material can be left on site to decompose.

Irrespective of the eradication method, follow-up control actions are essential to achieve complete eradication. Although Hudson pear does not produce viable seeds, broken-off cladodes have a high rooting ability, tolerate extreme temperatures and drought (Bobich & Nobel, 2001) and can survive for at least two years. This assures re-colonisation of cleared sites much in the same way a seed bank would do. Thus, cleared sites should be re-visited, though not too soon after removal of specimens, since sprouts from the cladode bank will be too small to be easily located. On the other hand, if the site is re-visited too long after clearance any new plants will be too large to be easily removed. Our experience shows that 3-4 years is the ideal timing under our climatic conditions between the initial extirpation and follow-up treatments.

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References

- Anon. (2012). *Weeds of National Significance: Opuntoid cacti (Austrocyllindropuntia, Cyllindropuntia, Opuntia spp.) Strategic Plan*. Australian Weeds Committee, Canberra.
- Bobich EG, Nobel PS (2001). *Vegetative reproduction as related to biomechanics, morphology and anatomy of four cholla cactus species in the Sonoran desert*. *Annals of Botany* 87: 485-493
- Johnson SB, Hosking JR, Chinnock RJ, Holtkamp RH (2009). *The biology of Australian weeds* 53. *Cyllindropuntia rosea (DC.) Backeb. and Cyllindropuntia tunicata (Lehm.) F.M.Knuth*. *Plant Protection Quarterly* Vol.24 (2).
- Henderson L (2012). *Focus on cacti in South Africa*. *Sapia News* 25.
- Sanz Elorza M, Dana Sánchez ED, Sobrino Vesperinas E (2004). *Atlas de las plantas alóctonas invasoras de España*. Ministerio de Medio Ambiente.
- Squeo FA, Arancio G, Gutiérrez JR, Letelier L, Arroyo MTK, León-Lobos L, Rentería-Arrieta L (2008). *Flora amenazada de la región de Atacama y estrategias para su conservación*. Ediciones Universidad de La Serena, La Serena.

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An overlooked biosecurity concern? Back-loading at islands supporting introduced rodents

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*Introduced House Mice *Mus musculus* were inadvertently back-loaded to a supply ship from mouse-infested Gough Island in the South Atlantic Ocean before the ship proceeded to place a party ashore on mouse-free Inaccessible Island. It is recommended that cargo from rodent-infested islands, especially that containing waste materials, be routinely inspected and treated on shore with rodenticides before back-loading commences. This is essential to reduce the risk of introducing rodents to departing vessels and then to rat- and mouse-free islands visited subsequently on the same voyages.*

Introduction

Oceanic islands and their native inhabitants are at risk to introduced species on a global scale. As a consequence much effort has been, and continues to be, put into control and eradication programmes with attendant publicity. Perhaps less publicised, but equally important, is the adoption of effective quarantine activities to reduce the chances of new introductions or re-introductions, especially to uninhabited and thus relatively pristine islands with largely intact ecosystems, including those where successful eradication exercises have been carried out. Under the general heading of “biosecurity”, sea-going vessels and their contents (both cargo and personnel) may undergo cleaning (such as the scrubbing of boots in a germicidal agent), fumigation, inspections for propagules, fitting with traps for rodents and invertebrates of various kinds and placing of poison bait stations, etc. before they leave home ports and in some cases while underway to their island destinations. Such measures may also be extended to packing stores and quayside localities at home ports. In a number of situations around the world, such biosecurity procedures are strictly adhered to by government agencies, shipping companies and tour operators alike.

Examples of biosecurity procedures in the southern hemisphere include those of national programmes (e.g. British Antarctic Survey, New Zealand Department of Conservation, South African National Antarctic Programme and Tasmania Parks & Wildlife Service) that visit sub-Antarctic islands and of tourist companies that are members of the International Association of Antarctica Tour Operators (IAATO). Both formal (e.g. via the Council of Managers of National Antarctic Programs; COMNAP and the Scientific Committee on Antarctic Research; SCAR) and informal sharing of information between such (and other) bodies is continuing to lead to a steady increase in best-practice procedures and protocols as loopholes are identified and new methods adopted to close them (e.g. de Villiers et al. 2006).

Within the South African National Antarctic Programme (SANAP) increasingly stringent biosecurity procedures have been adopted for voyages proceeding to the South African weather stations at Marion Island, Prince Edward Islands in the southern Indian Ocean and at Gough Island, Tristan da Cunha Group in the South Atlantic (Cooper and Ryan 1994; Prince Edward Islands Management Plan Working Group 1996; de Villiers and Cooper 2008; de Villiers et al. 2011; RSPB and Tristan da Cunha Government 2010).

It is a normal routine when supply ships visit islands in the Southern Ocean to backload waste materials for disposal at continental home ports. South Africa is no exception and waste materials are removed annually by relief expeditions departing from Gough and Marion Islands. However, little attention has been paid so far to biosecurity issues when departing from such islands despite the biosecurity efforts put in place prior to arrival (but see Lee and Chown 2011 for intra-regional transfer of plant propagules in the sub-Antarctic). Because both Gough and Marion are infested with introduced House Mice *Mus musculus* (that prey upon the islands’ avifauna; Cuthbert and Hilton 2004; Angel and Cooper 2006, 2011; Jones and Ryan 2011) the opportunity exists for predatory mice to be inadvertently back-loaded onto the supply vessel. If the vessel then proceeds to an island that does not support mice a new introduction could take place with potentially severe environmental consequences to that island’s ecosystem. We report here a case where mice came aboard the supply vessel from Gough Island before the ship proceeded to mouse-free Inaccessible Island (Ryan and Glass 2001) in the Tristan da Cunha Group.

Observations

On 12 September 2009 at Gough Island 12 large steel containers filled with domestic waste (mainly unwashed food cans, glass bottles, cardboard, paper and plastic wrapping generated by the weather station over a year) were back-loaded by helicopter to the S.A. Agulhas, South Africa's then Antarctic supply and research vessel, during the annual visit to the island to relieve the station. Several of these containers spent some time on the ship's forward main deck before being transferred to the hold. The next day a compactor previously used to crush food cans and mounted on a wooden pallet was back-loaded and stored aft in the open on the No. 2 deck (Fig. 1).

On the evening of 15 September while the ship was still lying off Gough evidence of a rodent aboard was found in the form of two nibbled chocolate bars in a store room leading off the passenger's lounge, which is situated close the vessel's forward main deck. A poison-bait container designed for rodents was moved to the site from elsewhere on the ship that night, followed by the placing of a small snap trap the following day, which had caught a large, presumed adult House Mouse by the next day, the 17th (Fig. 2). Unfortunately the mouse was not retained for examination.

On 17 September the S.A. Agulhas left Gough on a voyage to release weather buoys farther south and west in the South Atlantic. That same evening a second mouse was seen by two scientists aboard in the wet biological laboratory at the aft of the ship, emerging from a poison-bait station which had been present from when the ship sailed from Cape Town, its home port. The bait station in question was found to contain mouse droppings when inspected and photographed on 18 September, at which time the previously-used snap trap was placed nearby, but without success.

On departing from Gough on 4 October for the second time the S.A. Agulhas proceeded directly to mouse-free Inaccessible Island (whose management plan sets out detailed procedures to reduce the risks of rodents getting ashore; Ryan and Glass 2001). Once there on 5 October, it offloaded by helicopter two researchers and their cargo, that included food stuffs for an extended visit. Fortunately, no mice were seen when the Inaccessible cargo was unpacked ashore and the island remains, as far as it is known, mouse-free.



Figure 1. The compactor loaded aboard the S.A. Agulhas on 13 September 2009. Photo: John Cooper



Figure 2. Chief Steward Neville Genisson next to the store (see text) with the House Mouse caught aboard the S.A. Agulhas overnight on 16/17 September 2009. Photo: S.A. Agulhas



Figure 3. A SANAP container on the main forward deck of the S.A. Agulhas, showing two fork-lift slots in its base that are accessible to mice. Photo: John Cooper



Discussion

Given that these events occurred after the ship had commenced back-loading from the island, and that the vessel was believed to be free of rodents when it sailed from Cape Town earlier in the month (no evidence for mice being on board the ship was found in the first week of the voyage) it can be assumed that both mice came from Gough. The passenger lounge-mouse may have travelled within a fork-lift opening (Fig. 3) on one of the several SANAP waste containers flown from the island on the 12th, possibly from one that had been left temporarily on the deck. The compactor is thought more likely to have been the source of the second mouse as it was placed above the aft laboratories. On inspection aboard ship it was noted that the compactor had a number of openings in which a mouse could have stowed away while it was on the island at the weather station, which at times is heavily infested with mice (pers. obs.).

The waste containers and compactor had not been inspected for the presence of rodents ashore before being flown to the ship (Ryan et al. 2009). No further sightings or signs of mice were seen aboard the vessel, which returned to Gough from its buoy run on 27 September to complete the annual relief. It seems likely that the second mouse died from poisoning, but no carcass was ever found.

Other than in situations such as ship wrecks or deliberate introductions it is relatively unusual to know the precise time or route whereby biological invaders reach new islands. Due to this lack of knowledge broad measures are often taken to increase biosecurity for ships and personnel visiting islands in order to reduce the likelihood of new or re-invasions. However, whereas such biosecurity planning and steps are now implemented on many islands the risk from back-loading pest species from islands has, to date, been largely overlooked.

It is recommended that a back-loading biosecurity plan be developed and adopted within SANAP, which would include inspecting the contents and openings of cargo containers, especially those containing waste material such as unwashed food receptacles and food wrappings, before back loading commences. During the 2010, 2011 and 2012 annual reliefs of Gough Island this procedure was trialled, along with placing cereal-based poison bait pellets in the waste containers

a few days before back-loading commenced (Cuthbert 2010; Cooper and Louw 2011). No mice or their signs were noticed or reported aboard the ship on its return voyages to Cape Town.

Such a procedure should also take place during visits to Marion Island, given the close proximity of mouse-free Prince Edward Island, which is occasionally visited as part of annual reliefs. Mice have been back-loaded from Marion Island to the supply ship in waste containers in the past when poorly secured wooden boxes were used for the purpose (WM Leith, former Captain of the S.A. Agulhas pers. comm.; JC pers. obs.). We also recommend it as a standard procedure for all vessels taking aboard cargo from islands infested with rodents. Such vessels should also carry an adequate supply of regularly-inspected rodent (mouse and rat) poison bait stations and snap traps to be able to respond rapidly and effectively to any signs of rodents aboard. Lastly, it should be noted that back-loaded cargo treated with rodenticides must be treated as hazardous material aboard ship and once off-loaded at home ports.

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References

- Angel A. and Cooper J (2006) *A review of the impacts of introduced rodents on the islands of Tristan da Cunha and Gough*. Royal Society for the Protection of Birds, Sandy
- Angel A and Cooper J (2011) *A review of the impacts of the House Mouse *Mus musculus* on sub-Antarctic Marion Island, Prince Edward Islands*. Unpublished Report to the Prince Edward Islands Management Committee
- Angel A, Wanless RM and Cooper J (2009) *Review of impacts of the introduced house mouse on islands in the Southern Ocean: are mice equivalent to rats?* *Biological Invasions* 11 1743-1754

- Cooper J and Louw H (2011) *Gough Island Environmental Inspection Report, September-October 2011. Unpublished Report to the Tristan Conservation Department*
- Cooper J and Ryan PG (1994) *Management Plan for the Gough Island Wildlife Reserve. Government of Tristan da Cunha, Edinburgh, Tristan da Cunha*
- Cuthbert R (2010) *Gough Island Environmental Inspection Report to Tristan da Cunha September-October 2010. Unpublished Report to the Tristan Conservation Department*
- Cuthbert R and Hilton G (2004) *Introduced house mice *Mus musculus*: a significant predator of threatened and endemic birds on Gough Island, South Atlantic Ocean? Biological Conservation 117 483-489*
- de Villiers MS and Cooper J (2008) *Conservation and management. In: Chown SL and Froneman PW (eds) The Prince Edward Islands: Land-Sea Interactions in a Changing Ecosystem. Sun PReSS, Stellenbosch, pp. 113-131*
- de Villiers MS, Chown SL and Cooper J (2011) *Prince Edward Islands Conservation Handbook. SUN PRESS, Stellenbosch*
- de Villiers MS, Cooper J, Carmichael N, Glass JP, Liddle GM, Mclvor E, Micol T and Roberts A (2006) *Conservation management at Southern Ocean islands: towards the development of best-practice guidelines. Polarforschung 75 113-131*
- Jones MGW and Ryan PG (2010) *Evidence of mouse attacks on albatross chicks on sub-Antarctic Marion Island. Antarctic Science 22 39-42*
- Lee JE and Chown SL (2011) *Quantification of intra-regional propagule movements in the Antarctic. Antarctic Science 23 337-342*
- Prince Edward Islands Management Plan Working Group (1996) *Prince Edward Islands Management Plan. Department of Environmental Affairs & Tourism, Pretoria*
- RSPB and Tristan da Cunha Government (2010). *Gough and Inaccessible Islands World Heritage Site Management Plan April 2010 – March 2015. [Royal Society for the Protection of Birds, Sandy and Tristan Conservation Department, Edinburgh, Tristan da Cunha]*
- Ryan PG and Glass JP (2001) *Inaccessible Island Nature Reserve Management Plan. Government of Tristan da Cunha, Edinburgh, Tristan da Cunha*
- Ryan P, Glass, N and Cooper J (2009) *Gough Island Environmental Inspection Report, September-October 2009. Unpublished Report to the Tristan Conservation Department*

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Breynia disticha, a new invasive alien for tropical Africa

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In May 2012 during a botanical survey in the coastal Forecariah Prefecture of Guinea-Conakry in West Africa, a flowering specimen of a *Phyllanthus*-like shrub was collected in a patch of secondary forest on a granite inselberg (Cheek 16688, HNG, K; 9° 26' 23.4"N, 13° 23' 1.9W: see photographs Fig. 1 and 2). At the time it was assumed to be an indigenous species since there was no evidence of recent human disturbance at the site, nor any road access. The specimen was later identified at the Kew Herbarium by one of us (GC) as *Breynia disticha* J.R.Forst. & G. Forst. (Euphorbiaceae/Phyllanthaceae). This is a species native to Vanuatu in Melanesia through to New Caledonia (WCSP 2013) but widely cultivated through the tropics and subtropics as an ornamental plant in its pink and white varie-

gated form, often known as "var. *Nivosa*" or the 'snow bush'. Its range is erroneously given as "China and southeastern Asia through Malesia to Australia, New Caledonia and the New Hebrides" in www.hear.org/pier/species/breynia_disticha.htm. The genus *Breynia* J.R.Forst. & G.Forst. is a member of the family Phyllanthaceae – a family that was segregated from Euphorbiaceae sensu lato following molecular phylogenetic research Savolainen (2000); Angiosperm Phylogeny Group III (2009). Molecular studies have also confirmed that *Breynia* is embedded within the genus *Phyllanthus* L. Kathriarachchi et al. (2006), which is by far the largest genus in Phyllanthaceae. Wild species of *Breynia* occur from China to Australia, but never in Africa.



Figure 1 - The newly discovered Invasive form of *Breynia disticha* in Guinea (Cheek 16688), taken in May 2012 in Forecariah Prefecture.
Photos: Martin Cheek

Existing alien status

The variegated ornamental form of *Breynia disticha* has already been found to grow wild as an alien in areas where it was formerly cultivated in Florida and Hawaii, persisting due to its suckering habit. It is already listed as a cultivation escape, environmental and naturalised weed (www.hear.org/gcw/breynia_disticha/). It is assessed as being of low risk (-5) of invasiveness or of being a serious pest (regarding Australia, Pacific and USA-Florida) on PIER (www.hear.org/pier/wra/pacific/breynia_disticha_htmlwra.htm). The species has long been used in West Africa “widely cultivated as a hedge plant” Keay (1958), including in Guinea (Lisowski 2009). However, there is no evidence of the species being an aggressive invasive, until now.

Evidence for invasiveness

The site at which the plant was found in Guinea-Conakry was remote from any former habitation. Moreover, the plant was entirely non-variegated, possibly the first time that this has been recorded outside its native range, and appeared wild, competing on equal terms with indigenous species. On a subsequent visit to the area in September 2012, dozens more individuals of all-green, non-variegated *Breynia disticha* were seen along the roadsides in secondary evergreen thicket areas over many hectares (Cheek pers. obs.). In addition further non-variegated specimens of the plants came to light from other botanical surveys in 2012, one 15km distant from the first, in *Elaeis* forest at the edge of mangrove (Pollard 1490, HNG, K; 9° 25' 27.1"N, 13° 14' 27.1"W) and the other 390km inland in Guinean woodland (Guilavogui 525, HNG, K; 9° 39' 3.6"N, 9° 19' 55.6"W). It is clear that *Breynia disticha*, in its non-variegated state, has become invasive in Tropical Africa in several habitats. From the pattern of its occurrence in Guinea, it appears to be spreading not by suckers, but by seed, since it can occur in sites remote from human settlement, where there is no evidence of former cultivation. It was recorded in fruit from the original site in July 2012 by one of us (Molmou 486).

The threat of *Breynia disticha* is its ability to colonise and persist in secondary forest is of great concern since potentially it could further threaten already rare native species by out-competing and displacing them. Only 200m distant from the site of the first discovery of *Breynia disticha* in Guinea is a small patch of intact forest containing what is thought to be the last surviving global location for the forest understorey shrub *Tarenna hutchinsonii* (Ru-

biaceae) and several other threatened species. There is a high risk that the all-green, invasive form of *Breynia disticha* will spread eastwards into nearby Sierra Leone, and beyond, colonising Tropical Africa. Equally, the species may initially have become established as an invasive in Sierra Leone (or further eastwards) before spreading west to Guinea-Conakry where we detected it.

Origin and dispersal of the invasive all-green *Breynia disticha*

Breynia species are known to produce fleshy seeds, and we consider that bird dispersal of the seeds is likely. It can be deduced that the invasive plants here reported in Guinea-Conakry arose from a chance reversion to the wild, all-green state from the selected horticultural forms introduced to Guinea in the French Colonial period that ended in 1956. Elsewhere in Guinea, we have found in recent years that clusters of non-native ornamental species are a reliable indicator of the existence of former colonial establishments. Presumably the wild, all-green form of *Breynia disticha* is more vigorous than the variegated form, having more chlorophyll, which might in turn give rise to greater rates of seed-set, and so higher chances of seed dispersal than in the variegated state, in which fruits are rarely if ever seen (pers. obs.). This is supported by our observation that none of the 25 specimens from around the world of the variegated form at the Kew Herbarium bear fruit, and one such specimen bears the observation “flowers abortive” (Deighton 5571, Sierra Leone).

Control measures

We suggest that control of the all-green *Breynia disticha* in Tropical Africa might be achieved by digging up plants with their root systems intact and burning, so as to avoid suckering and persistence. Identification of and control of the species along roadsides is not difficult due to the distinctive growth-form which is unlikely to be confused with any native Guinean species. However, plants which occur at any distance from the road will be extremely difficult to find and control. The fact that the species is already widespread in Guinea in several different vegetation types suggests that in reality it will be extremely difficult to eradicate. The species is already probably a long-term if unwelcome addition to the Flora of Guinea-Conakry.



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Generally speaking, very few alien invasive species are known in evergreen forest habitats of West and Central Africa, exceptions being *Cecropia peltata* and *Ochroma lagopus* which are primary pioneers competing on equal terms with the native *Musanga cecropioides* in Cameroon, and *Alternanthera brasiliensis* an understory herb (Cheek 2004).

Field identification of *Breynia disticha*

Most species of *Breynia*, and of the closely related genus *Phyllanthus* (a genus that is widespread in tropical and subtropical regions of the world including Guinea), are recognisable by their characteristic phyllanthoid branching, where lateral axes resemble a legume compound leaf: leaves on lateral (plagiotropic) axes develop normally while leaves on the main axes are reduced to scales called cataphylls (Webster 1956).

In *Breynia disticha* (all-green form in Guinea) several main axes arise vertically from the ground, arcing gradually away from the centre until they are horizontal. Usually they are unbranched. The plants reach a height of 1-4m (but in the wild to 9m, e.g. McPherson 19469 from Vanuatu), lacking coloured exudate, scent or spines. The lateral (plagiotropic) branches arise from alternate nodes on each side of the main axis (distichous), at intervals of 20-40mm. The lateral branches are horizontal, 10-25 cm long in mature plants, bearing alternate leaves at intervals of 5-8mm. The leaf-blades are held in the horizontal plane, are thinly papery, dark green, elliptic-oblong or elliptic-ovate, the largest leaves on each stem are c. 30-45x15-30mm, with a rounded apex and base, and with 5-6 lateral nerves on each side of the midrib. The leaf-stalk is 2-3 mm long. Stipules are inconspicuous, 1 mm long. Lateral stems can bear both male flowers (smaller, 2-5mm wide, near lateral stem bases) and female flowers (c.12mm wide, with a saucer like-calyx, towards stem apices). The flowers are inconspicuous, green-yellow, held below the stems, no more than one per leaf axil on slender stalks 6-8 mm long (male) or stout, to 8mm long (female) long. The fruits are globose, c.5mm diam. When mature (not observed) they should open by 3valves exposing 6 orange-segment shaped seeds. In *B. disticha* var. *neocaledonica* seeds are 3x2mm.

Further work is needed to map and study the range, biology and persistence of this newly identified alien invasive species in West Africa, and to monitor and control its spread. In particular research is needed to trial the effectiveness of the suggested control measures and to improve understanding of the repro-

duction of the species in Africa. Currently the pollination system of the invasive form is unknown, as are the means of dispersal

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References

- Angiosperm Phylogeny Group (APG) III. 2009 An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* 161: 105-121.
- Cheek, M. 2004. *Invasive, Alien and Weedy Plants*, pp. 70-74 in Cheek et al., *The Plants of Kupe, Mwanenguba and the Bakossi Mountains, Cameroon, a Conservation Checklist*. Royal Botanic Gardens, Kew, London.
- Global Compendium of Weeds. *Hawaiian Ecosystems at Risk*. www.hear.org/gcw/breynia_disticha/ downloaded December 2012.
- Kathriarachchi et al. 2006 Phylogenetics of tribe Phyllanthaceae (Phyllanthaceae; Euphorbiaceae *Sensu Lato*) based on nrITS and plastid matK DNA sequence data. *Am.J.Bot.* 93(4) : 637-655
- Keay, R.W.J. 1958. *Flora of West Tropical Africa* vol 1: 368. Crown Agents, London.
- Lisowski, S. 2009. *Flore de la République de Guinée*. *Scripta Botanica Belgica* 41.
- Pacific Islands Ecosystems at Risk* www.hear.org/pier/wra/pacific/breynia_disticha_htmlwra.htm downloaded December 2012.
- Savolainen, V., M. F. Fay, D. C. Albach, A. Backlund, M. van der Bank, K. M. Cameron, S. A. Johnson, M. D. Lledó, J.-C. Pintaud, M. Powell, M. C. Sheahan, D. E. Soltis, P. S. Soltis, P. Weston, W. M. Whitten, K. J. Wurdack, and M. W. Chase. 2000. Phylogeny of the eudicots: A nearly complete familial analysis based on rbcL gene sequences. *Kew Bulletin* 55: 257-309.
- Webster, G. L. 1956. A monographic study of the West Indian species of *Phyllanthus*. *Journal of the Arnold Arboretum* 37: 91-122, 217-268, 340-359.
- 'World Checklist of Selected Plant Families'(2013) Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; <http://apps.kew.org/wcsp/> Retrieved 03.01.2013

The eradication of feral cats from Dassen Island: a first for Africa?

JOHN COOPER AND BRUCE M. DYER

Feral domestic cats Felis silvestris catus were eradicated from South Africa's Dassen Island in March 2002, following three decades of intermittent control and eradication attempts. Once the last few cats are removed from nearby Robben Island all South African islands will be free of this alien predator. Freeing Dassen Island of cats appears to be the first such success for the African Continent as a region.

Introduction

In their review of the eradication of feral domestic cats *Felis silvestris catus* from islands world-wide Nogales et al. (2004) list 46 islands where success had been achieved, none of which falls within the African continental region. The authors make a plea for successful eradication efforts to become better known, noting that many remain unpublished or buried in internal reports. We report here on the eradication of feral cats from what we believe to be the first African island, after three decades of intermittent control efforts. Because this successful eradication has never been fully documented, it was not available for listing in the 2004 review, although the last cat was killed in 2002.

Dassen Island (33° 25'S, 18° 06'E) is a 220-ha low-lying island situated 9 km off the Atlantic coast of the Western Cape Province of South Africa. It is inhabited by a suite of seabird species, notably the African Penguin *Spheniscus demersus* which was historically exploited for its eggs and guano, prior to becoming a Provincial Nature Reserve in March 1988 (Rand 1963; Seal et al. 2011). Dassen has also supported populations of introduced European Rabbits *Oryctolagus cuniculus* since the 1660s and feral cats since about 1890 (Cooper and Brooke 1982; Brooke and Prins 1986). As well as on the rabbits, the cats are known to have preyed upon and scavenged from several species of the island's birds, including penguins, Cape Cormorants *Phalacrocorax capensis*, Kelp Gulls *Larus dominicanus*, migratory terns *Sterna* spp., African Black Oystercatchers *Haematopus moquini*, Crowned Lapwings *Vanellus coronatus*, Helmeted Guinea Fowl *Numida meleagris*, Cape Wagtails *Motacilla capensis*, European Starlings *Sturnus vulgaris* and domestic chickens *Gallus gallus*, as well as on alien House Mice *Mus musculus* and arthropods (Cooper 1977; Apps 1981, 1983; Berruti 1986; BDM personal observation).

Control and eradication efforts - 1971-1972

The first efforts to eradicate (or at least control) Dassen's feral cats that we are aware of took place during 1971-1972 when

the senior author attempted to shoot with a .22 rifle all animals he encountered while conducting field research during daylight hours on the island's seabirds. A female kitten that was caught on the island by hand and tamed attracted several male cats once it became sexually mature that were then shot at close range (see Cooper 1977). About 20 cats (including kittens) were killed; with most of the adults being males. Although no attempt was then made to estimate the number of cats on the island, it is considered that the island's population was not greatly affected by the small numbers removed.

1976-1984

According to Apps (1984) "culling pressure" on Dassen's cats was severe in 1976-1977. Brooke and Prins (1986) state that "[i]n the mid-1970s the Sea Fisheries Research Institute guano staff had reduced the population to a very low level". No other details are available.

Over the period 1979/80 and again in March 1981 Peter Apps of the University of Pretoria studied the behaviour and ecology of Dassen's cats (1983, 1984, 1986). During this period and until at least 1983 no killing of cats took place. Their numbers increased rapidly as a consequence from an estimated 20-25 in May 1979 to 37-50 in June 1980 and to 65-85 in March 1981 (Apps 1984, 1986; Cooper et al. 1985). Apps (1984) predicted that the population would have reached 100-140 animals by March 1982 (but his estimate is given as 98-115 in Berruti 1986). Later estimates of 107-127 by Peter Apps are cited by Berruti (1986) for both March 1983 and March 1984. Cooper et al. (1985) estimated that over 2 000 birds a year were being killed by Dassen's feral cats in 1983, although Berruti (1986) placed his estimate for 1985 at 600 birds.

1985-2002

For several years in the 1980s Dassen Island was used as a training ground for cat shooters destined for Marion Island in the sub-Antarctic (MN Bester personal communication). The cat population on Dassen Island in March 1985 was estimated to be approximately 80, less than the estimates made by



Peter Apps for March 1982, perhaps because of a reduction of the rabbit population, the cat's main prey (Berruti 1986). During March-May 1985 c. 70 cats (including kittens) were killed by day and night hunting with rifles and shotguns and by deploying (less successfully) live-capture traps. There was no significant difference in the sex ratio of cats killed. Fewer than 10 individuals were thought to be left after this operation (Berruti 1986).

Shooting and live-trapping (which included of kittens; L Swart pers. comm.) continued from 1985 to 1997 intermittently on an ad hoc basis, mainly in response to sightings with no directed campaign of eradication (AC Wolfaardt in litt.). During 1995, five cats were shot, reducing the frequency of cat sightings substantially thereafter. A single cat was seen in 1996 and two cats were shot in 1998 (BMD unpublished information). A pet cat kept by a resident lighthouse keeper was removed from the island in 1992.

In 2000 a first management plan was produced for the Dassen Island Nature Reserve. A stated policy of this plan was to eradicate the cats as a "priority management function" and methods to be used were set out in some detail. However, in the event only limited resources were made available to undertake the task and as a consequence efforts continued to be intermittent (AC Wolfaardt in litt.). The last cat on the island was killed on 5 March 2002 (Saul et al. 2011). No cats have been subsequently seen on the island despite many research visits by BMD to the present day.

Discussion

It was a solely African effort that led to the eradication of feral cats from what is still the largest island on which this has been achieved (Nogales et al. 2004). In 1991 South Africa killed the last cat on Marion Island (at 290 km²), following a continuous campaign that successively utilized disease, day and night hunting, trapping and poisoning over a 15-year period (Bester et al. 2002). In contrast it took twice as long (30 years) to eradicate the cats from Dassen Island, less than 1% the size of Marion and with far less challenging environmental conditions.

The slow progress with eradicating Dassen Island's cats seems to lie with both a lack of institutional commitment and of a properly designed and executed eradication campaign

that was sustained until completion. In our experience, a body of opinion has existed within South Africa (and may still exist) within some management authorities that alien animals, including predators such as feral cats, on island nature reserves have cultural and intrinsic values and should therefore not be removed, or at best, should just be controlled (e.g. see de Villiers et al. 2010).

The eradication of Dassen's cats is thought to have contributed to an increase in the island's hitherto low African Black Oystercatcher population, and to commencement of breeding by Greater Crested or Swift Terns *Sterna bergii* and Hartlaub's Gulls *Larus hartlaubii*, both species that did not breed on the island in the 1970s to early 1980s (Cooper et al. 1983; Hockey 1983; Cooper et al. 1990; Williams et al. 1990).

There are lessons here for other islands and situations. Nearby Robben Island (507 ha, 33° 49'S, 18° 22'E; Crawford and Dyer 2000), a World Heritage Site in Table Bay, continues to support feral cats that have preyed upon the island's indigenous bird life, including African Penguins, Hartlaub's Gulls, Greater Crested Terns and African Black Oystercatchers, as well as on its alien European Rabbits and Black Rats *Rattus rattus* for at least half a century (Braby and Underhill 2007; Tjørve and Underhill 2008; de Villiers et al. 2010; BMD personal observation). This is despite (or because of) a similar saga of on-and-off control and eradication efforts with 107 cats killed in 1998 and at least 58 in 2005 (Crawford and Dyer 2000; de Villiers et al. 2010; J Kieser personal communication; BMD unpublished information) that were not carried through to completion due to insufficiently sustained support. As a consequence Robben's cat numbers have fluctuated up and down markedly over the last several decades (Crawford & Dyer 2000, de Villiers et al. 2010, BMD personal observation), as they did on Dassen Island over at least three decades of inadequate control.

The management authority for Robben Island initiated a rabbit-control programme in October 2009 when opportunity was taken to remove any cats detected by night-time shooting. Twenty-six cats were killed in 2009, 30 in 2010, 15 in 2011, 11 in 2012 and five have been killed in 2013 up to 31 March, with the current population believed to be less than 10 (C Wilke personal communication, 4 April 2013).

We hope that South Africa in the future will be able to announce that all the islands under its control, both continental and sub-Antarctic (Brooke and Prins 1986; Cooper and Brooke 1986), are finally free of this major and unwanted alien predator.

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References

- Apps PJ (1983) *Aspects of the ecology of feral cats on Dassen Island, South Africa*. *South African Journal of Zoology* 18: 393-399
- Apps PJ (1984) *Cats on Dassen Island*. *Acta Zoologica Fennica* 172: 115-116.
- Apps PJ (1986) *Home ranges of feral cats on Dassen Island*. *Journal of Mammalogy* 67: 199-200
- Berruti A (1986) *The predatory impact of feral cats Felis catus and their control on Dassen Island*. *South African Journal of Antarctic Research* 16: 123-127
- Bester MN, Bloomer JP, van Aarde RJ, Erasmus BH, van Rensburg PJJ, Skinner JD, Howell PG and Naude TW (2002) *A review of the successful eradication of feral cats from sub-Antarctic Marion Island, southern Indian Ocean*. *South African Journal of Wildlife Management* 32: 65-73
- Braby J and Underhill LG (2007) *Was poor breeding productivity of African Black Oystercatchers on Robben Island in 2004/05 caused by feral cats, Kelp Gulls, mole snakes or the Sumatran tsunami?* *Wader Study Group Bulletin* 113: 66-70
- Brooke RK and Prins AJ (1986) *Review of alien species on South African offshore islands*. *South African Journal of Antarctic Research* 16: 102-109
- Cooper J (1977) *Food, breeding and coat colour of feral cats on Dassen Island*. *Zoologica Africana* 12: 250-252
- Cooper J and Brooke RK (1982) *Past and present distribution of the feral European rabbit Oryctolagus cuniculus on southern African offshore islands*. *South African Journal of Wildlife Research* 12: 71-75
- Cooper J and Brooke RK (1986) *Alien plants and animals on South African continental and oceanic islands: species richness, ecological impacts and management*. In: MacDonald, IAW, Kruger FJ and Ferrar AA (eds) *The ecology and management of biological invasions in southern Africa*. Oxford University Press, Cape Town, pp 133-142
- Cooper J, Crawford RJM, Suter W and Williams AJ (1990) *Distribution, population size and conservation of the Swift Tern Sterna bergii in southern Africa*. *Ostrich* 61: 56-65
- Cooper J, Hockey PAR and Brooke RK (1985) *Introduced mammals on South and South West African islands: history, effects on birds and control*. In: Bunning, LJ (ed) *Proceedings of the Symposium on Birds and Man, Johannesburg 1983*. Witwatersrand Bird Club, Johannesburg. pp 179-203
- Crawford RJM and Dyer BM. (2000) *Wildlife of Robben Island*. University of Cape Town, Rondebosch
- de Villiers MS, Mecenero S, Sherley RB, Heinze E, Kieser J, Leshoro TM, Merbold L, Nordt A, Parsons NJ and Peter H-U (2010) *Introduced European rabbits (Oryctolagus cuniculus) and domestic cats (Felis catus) on Robben Island: population trends and management recommendations*. *South African Journal of Wildlife Research* 40: 139-148
- Hockey, PAR (1983) *The distribution, population size, movements and conservation of the African Black Oystercatcher Haematopus moquini*. *Biological Conservation* 25: 233-262
- Nogales M, Martín A, Tershy BR, Donlan CJ, Veitch D, Puerta N, Wood B and Alonso J (2004) *A review of feral cat eradication on islands*. *Conservation Biology* 18: 310-319
- Rand RW (1963) *The biology of guano-producing seabirds 4. Composition of colonies on the Cape Islands*. *Investigational Report of the Division of Sea Fisheries of the Union of South Africa* 43: 1-32
- Saul L, Visagie J, Cleaver G and Hayward N (eds) (2011) *Dassen Island Nature Reserve Management Plan*. CapeNature, [Cape Town]
- Tjørve KMC and Underhill LG (2008) *Influence of disturbance and predation on breeding success of African Black Oystercatchers Haematopus moquini on Robben Island, South Africa*. *Waterbirds* 31: 83-96
- Williams AJ, Steele WK, Cooper J and Crawford RJM (1990) *Distribution, population size and conservation of Hartlaub's Gull Larus hartlaubii*. *Ostrich* 61: 66-76





The box tree moth, *Cydalima perspectalis*, in Europe: horticultural pest or environmental disaster?

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The box tree moth, *Cydalima perspectalis*, was accidentally introduced in Europe some years ago, most likely through the trade of live plants. Within a few years it has already invaded at least 16 countries, in which it has become a serious pest of ornamental box trees (*Buxus* spp.). However, it is its impact on natural box tree stands that causes the most concern. It has already severely damaged isolated box populations in Germany and Switzerland, up to their local extirpation. Its spread and establishment in other parts of the natural distribution areas of the two European box trees species will undoubtedly have negative consequences on unique forest ecosystems, especially if nothing is done to control the pest. Populations in Southern Europe, which are naturally severely reduced, are particularly at risk.



Fig. 1. Larva of *Cydalima perspectalis*. Photo: Tim Haye



Fig. 2. Adult of *Cydalima perspectalis*. Photo: Tim Haye

Introduction

The live plants trade is the main pathway of introduction of exotic plant pests. Some of them can become serious threats to indigenous plants and, by cascading effects, to the ecosystem in which they live. A recent example in Europe is the arrival of the box tree moth, *Cydalima perspectalis* (Walker) (Lep: Crambidae). This insect originates from East Asia (China, Japan and Korea) and was first discovered in South-western Germany and the Netherlands in 2007. *Cydalima perspectalis* most likely arrived via the trade of box plants (*Buxus* spp.) from Asia and within a few years, has become a serious pest of one of Europe's most popular ornamental shrubs. The moth has also invaded several natural *Buxus* populations in Central Europe.

Biology and Ecology

Eggs are laid in patches on the abaxial surface of box leaves. Young larvae overwinter in diapause in a cocoon built between leaves. Diapause is induced by day length and temperature experienced by young larvae (Maruyama and Shinkaji 1993). Larval feeding (Fig. 1) continues in spring and pupation also occurs in the foliage. In northern Switzerland, *C. perspectalis* completes two generations per year, with adults (Fig. 2) flying in June and August-September (Nacambo et al. 2013). In warmer areas, three and even four generations per year may occur. Although other plant genera (e.g. *Ilex* and *Euonymus*) are reported as hosts in Asia, *C. perspectalis* has been recorded in Europe exclusively on *Buxus*. On the other hand, it feeds on all of the widely used box species and cultivars in Europe (Leuthardt and Baur 2013).

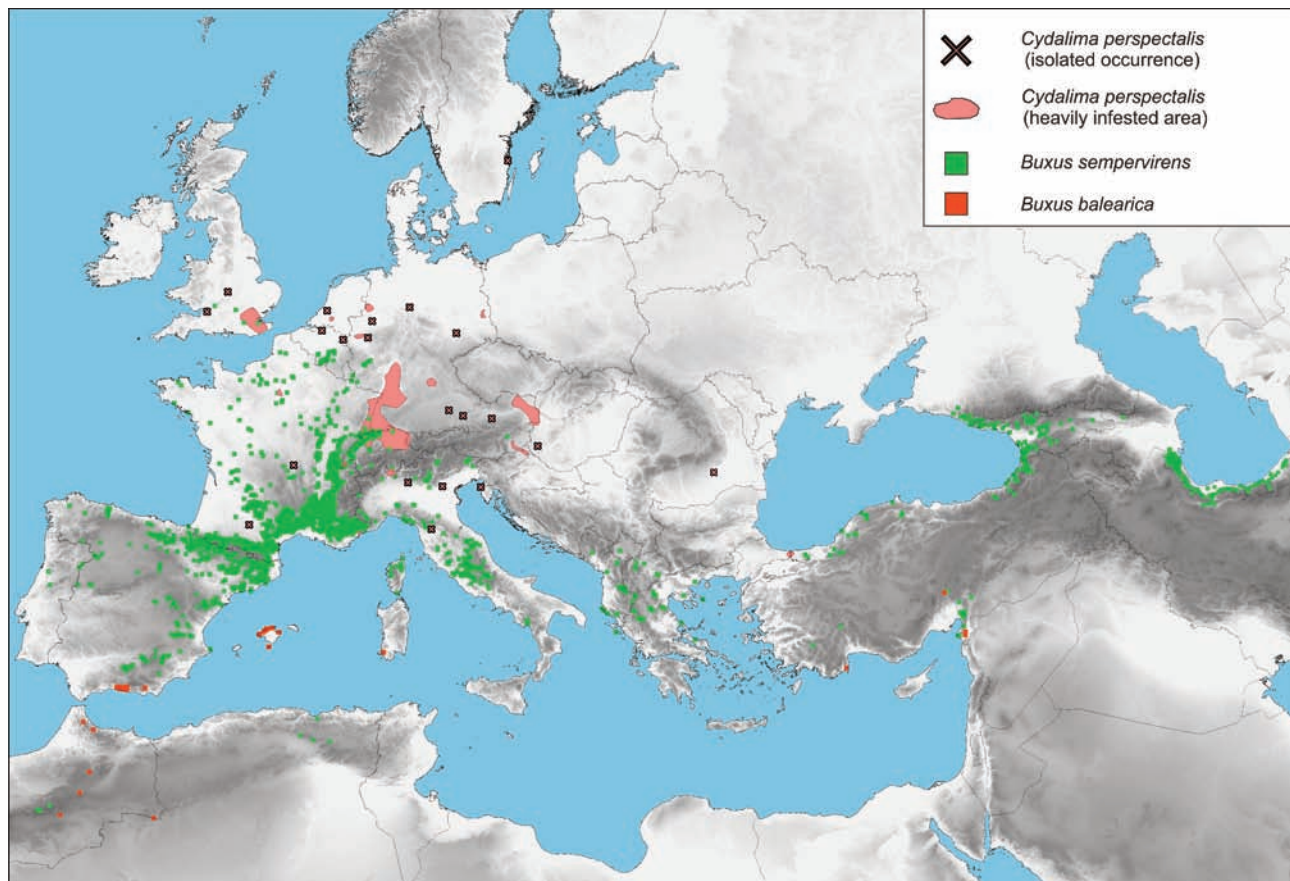


Fig. 3. Natural distribution of the two *Buxus* spp. (modified from Di Domenico et al. 2012) and known distribution of *Cydalima perspectalis* in Europe in December 2012 (references in Nacambo et al. 2013)

Actual and potential spread in Europe

At the end of 2012, i.e. five years after the first record in Germany and the Netherlands, *C. perspectalis* was officially present in 16 countries (Fig. 3). Although adults are good flyers, the rapid spread of the moth in Europe is mainly due to the trade of ornamental box trees. Eggs and young larvae can travel inconspicuously on their evergreen host plants. Moreover, the European Union is a free market for live plants and *C. perspectalis* is not listed in the EC Plant Health Directive or classified as a quarantine pest by the European and Mediterranean Plant Protection Organisation (EPPO)

A climate model (Nacambo et al. 2013) showed that the moth is able to spread and establish successfully in most of Europe, except in most of Fennoscandia and Scotland. It is likely, however, that populations and damage will be higher in the Southern half of Europe, where *C. perspectalis* is able to develop two or more generations per year.

Impact

Larvae feed mainly on leaves but may also attack the bark. Total defoliation is common (Fig. 4) and usually results in the death of the trees. The effect of the moth is often aggravated by the occurrence of the box blight, caused by the fungal pa-

thogen *Cylindrocladium buxicola* Henricot, another invasive species that arrived in Europe a few years before *C. perspectalis*. In infested areas, it has become impossible to maintain healthy box trees without chemical treatment or laborious mechanical removal of larvae. Box trees have played a central role through the centuries in the landscape of European gardens, including historical villas, parks and cemeteries but, since the arrival of the pest, it has become common practice to replace *Buxus* with other plant species.

Besides cultural and economic effects, the most serious threat from *C. perspectalis* is likely to be on the natural *Buxus* populations. Two box tree species naturally occur in Europe. The common box (*B. sempervirens*) is widely present across Central and southern Europe, whereas the Balearic box (*B. balearica*) occurs in southern Spain, Balearic Islands and Sardinia (Fig 3). Populations of *B. sempervirens* in the temperate regions of Western Europe are rather abundant and continuous. In contrast, in Southern Europe both *B. sempervirens* and *B. balearica* are characterized by fragmented and locally scarce populations. The two species are also found in North-West Africa and Turkey, and *B. sempervirens* extends eastwards to Georgia, Russia, Kazakhstan and Iran (Fig 3). *Buxus* spp. populations located in southern Europe underwent severe reduction in the last few millennia and are still undergoing a process of fragmentation and local isolation (Di Domenico et al. 2012).

The distribution of the moth and that of the natural box tree populations do not yet overlap, with the exception of the Nor-





Fig. 4. Ornamental box tree killed by *Cydalima perspectalis* in Switzerland. Photo: Tim Haye



Fig. 5. Natural stand of *Buxus sempervirens* defoliated by *Cydalima perspectalis* in Grenzach-Whylen (Germany). Photo: Tim Haye

thern Jura Mountains in north-western Switzerland and south-western Germany, where a few isolated but dense stands of *B. sempervirens* are found. Between 2009 and 2010, some of the populations located near the city of Basle have been destroyed by the moth (John and Schumacher 2013). In the Nature Reserve of Grenzach-Whylen, which hosts the largest box tree forest in Germany, all shrubs lost more than 90% of their foliage and 27% of them lost all their leaves (Fig. 5). More alarmingly, and despite a strong decrease in moth population levels in 2011, a tree-marking experiment revealed that box trees had not recovered in 2012 and that all the plants that had been completely defoliated in 2010 died (Nacambo 2012). This suggests that *B. sempervirens* is not able to survive total defoliation. A change of the ground covering vegetation due to increased exposure to sunlight has already been observed (John and Schumacher 2013). New stands were defoliated in late 2012, causing serious concerns for the survival of *B. sempervirens* in the region. The imminent arrival of *C. perspectalis* in the main distribution areas of *B. sempervirens* in the French Massif Central and the Pyrenees will undoubtedly have severe consequences, not only on the plant species itself, but also on the functioning of unique forest ecosystems as a whole. Furthermore, the invasive moth may also threaten the survival of *B. sempervirens* and the rare *B. balearica* in southern Europe, where they already experience a historical decline.

Recommendations for management

Cultivated box trees can be protected by chemical insecticides or, preferably, biopesticides based on *Bacillus thuringiensis* (Bt). In private gardens with few trees, the moth may be controlled by hand picking caterpillars, by shaking trees or by spraying water. In forests, however, these methods are not adequate. Given the urgency of the situation, a classical biological control program based on the introduction of a specific natural enemy from the region of origin probably provides the only sustainable solution. Surveys in Switzerland showed that the natural enemy complex in Europe is very poor. Larval parasitism was less than 1% and represented by a single tachinid parasitoid, *Pseudoperichaeta nigrolineata* (Walker) while no egg or pupal parasitoids were found (Nacambo 2012). Predators were not commonly observed either, possibly due to the sequestration of toxic alkaloids from their host-plant (Leuthardt et al. 2013). A few parasitoids are mentioned in the Asian literature but little is known on their efficiency and specificity. Furthermore, these records are restricted to ornamental plants in urban areas while surveys for natural enemies in the area of origin should be made primarily in the native habitats of *Buxus* spp.

Acknowledgements

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References

- Di Domenico F, Lucchese F, Magri D (2012) *Buxus* in Europe: Late Quaternary dynamics and modern vulnerability. *Perspect. Plant Ecol Evol Syst* 14:354-362.
- John R, Schumacher J (2013) Der Buchsbaum-Zünsler (*Cydalima perspectalis*) im Grenzach-Wyhlener Buchswald – Invasionsschronik und Monitoringergebnisse. *Gesunde Pflanzen* 65:1–6.
- Leuthardt FLG, Baur B (2013) Oviposition preference and larval development of the invasive moth *Cydalima perspectalis* on five European box-tree varieties. *J Appl Entomol* DOI: 10.1111/jen.12013.
- Leuthardt FLG, Glauser G, Baur B (2013) Composition of alkaloids in different box-tree varieties and their uptake by the box-tree moth *Cydalima perspectalis*. *Chemoecology* DOI: 10.1007/s00049-013-0134-1.
- Maruyama T, Shinkaji N (1993) The life cycle of the box-tree pyralid, *Glyphodes perspectalis* (Walker) (Lepidoptera: Pyralidae). III. Photoperiodic induction of larval diapause. *Jpn. J Appl Entomol Zool* 37:45-51. (In Japanese with English abstract).
- Nacambo S (2012) Parasitisme, développement, modèle climatique et impact de *Cydalima perspectalis* en Europe. MSc thesis, University of Neuchâtel, Switzerland.
- Nacambo S, Leuthardt FLG, Wan H, Li, H, Haye T, Baur B, Weiss RM, Kenis M (2013) Development characteristics of the box-tree moth *Cydalima perspectalis* and its potential distribution in Europe. *J Appl Entomol* (in press).

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Recent introduction and spread of Indian bullfrog *Hoplobatrachus tigerinus* (Daudin, 1802) into the Andaman Islands

HARIKRISHNAN SURENDRAN AND KARTHIKEYAN VASUDEVAN

The ecological release experienced by invasive species in islands enables them to establish quickly, increase their population, and out-compete indigenous species. This often leads to the extinction of indigenous and endemic species (Simberloff and Rejmanek, 2010). Among amphibians and reptiles, the best known examples of invasive species are cane toads (*Rhinella marina*) in Australia and brown tree snakes (*Boiga irregularis*) in Guam (Lever, 2001; Savidge, 2008). The Andaman and Nicobar Islands (India) in the Bay of Bengal have several species of introduced or invasive animals (Ali, 2004 & 2006). The effects of feral elephants and invasive spotted-deer on local vegetation in some islands in the Andaman Islands are well documented (Ali, 2004).

Apart from house geckos (*Hemidactylus frenatus* and *Hemidactylus brookii*), the only invasive reptile that seems to have established itself in anthropogenic modified habitats is the Asian garden lizard (*Calotes versicolor*) which we found in at least five major islands, viz., North Andaman, Middle Andaman, South Andaman, Little Andaman and Car Nicobar. Until recently

there was no known case of an invasive amphibian species in the Andaman and Nicobar Islands. The Andaman and Nicobar Islands host 19 species of amphibians including four endemics (Das, 1999a; Harikrishnan et al., 2010). Ten of these are found in the Andaman Islands. The largest amphibian native to these islands is the common Asian toad (*Duttaphrynus melanostictus*).

In 2011, Saw John Aung Thong, Manager at the Andaman and Nicobar Environmental Team (ANET), Port Blair alerted us to the presence of a large greenish brown frog in paddy fields in Mayabunder, Middle Andaman Island. The frog was reportedly brought by some farmers from West Bengal 3-4 years ago and released into rice fields in Mayabunder, presumably for local consumption. In May 2012, a resident at Lamiya Bay, in North Andaman Island informed us that he had collected some live frogs from Mayabunder, Middle Andaman Island and released them into the paddy fields in Lamiya Bay, near Saddle Peak National Park. Although, we conducted a search for these 'mystery frogs' near Lamiya Bay, we could not locate it; probably due to the dry weather that prevailed during our surveys.



Figure 1. Indian bullfrog (*Hoplobatrachus tigerinus*) from Webi, Mayabunder, Middle Andaman Island. Photo: Harikrishnan Surendran

As part of an on-going study on terrestrial herpetofauna on Andaman and Nicobar Islands, we visited Mayabunder, Middle Andaman Island in October 2012. We surveyed forested areas and conducted visual encounter surveys along streams and paddy fields in the evening. These surveys revealed that the large frog in question was Indian bullfrog *Hoplobatrachus tigerinus* (Daudun, 1802) (Fig. 1). It was very common along the edge of streams and paddy fields in Mayabunder. A few large individuals were also seen along forest streams approximately 1.5 km away from the forest edge. Local people informed us that these frogs were very numerous during the early part of the monsoon (May-August). On 6 May 2013, two bullfrogs were found near paddy fields in Wandoor, South Andaman Island. We have reason to believe that these are new arrivals as we have camped and surveyed this region since 2008 and bullfrogs were never recorded here previously.

The Indian bullfrog (*Hoplobatrachus tigerinus*) is a widespread species in South Asia, occurring in Afghanistan, Bangladesh, India, Myanmar, Nepal, Pakistan and Sri Lanka. Madagascar and Maldives harbour introduced populations of this species (Dutta, 1997; Glaw & Vences, 2007). This large species (adult snout-vent length up to - 158 mm according to Boulenger, 1920) feeds on invertebrates and small vertebrates. Local people in Mayabunder reported that they ate small chickens. While it seems to be confined to a few localities in the Andaman Islands, the bullfrog has the potential to become yet another problematic invasive in the Andaman Islands. 1) Its large size could enable this species to competitively exclude and predate on other frog species in the Andaman Islands. 2) It is a prolific breeder and the population could increase rapidly. 3) This species breeds in the beginning of the monsoon and the tadpoles are carnivorous, feeding on tadpoles of other species of frogs (Khan, 1996). In mainland India, it is also known to feed on small snakes, lizards and rodents, all of which have numerous endemic species in these islands (Das, 1999b). However, there are also frog-eating species of snakes in these islands, such as the Indian rat snake (*Ptyas mucosa*) and Andaman keelback (*Xenochrophis tytleri*), adults of which could be capable of predated on bullfrogs.

We believe that the Indian bullfrog is an invasive species in the Andaman Islands that has already established itself in some localities and has the potential to negatively affect the local frog fauna. The Indian bullfrog is protected in India by Wildlife (Protection) Act, 1972 (Schedule IV), so management interventions have to be approved by the Department of En-

vironment and Forests, Andaman and Nicobar Islands to control the species. However, at present, we lack information on population size, distribution and the impacts of Indian bullfrogs on other species.

References

- Ali, R (2006) *Issues relating to invasives in the Andaman Islands. Journal of the Bombay Natural History Society*, 103: 349-355.
- Ali, R (2004) *The effect of introduced herbivores on vegetation in the Andaman Islands. Current Science*, 86: 1103-1112.
- Boulenger, G A (1920) *A monograph of the south Asian, Papuan, Melanesian and Australian frogs of the genus Rana. Records of the Indian Museum*, 20: 1-115.
- Das, I (1999a) *Biogeography of the amphibians and reptiles of the Andaman and Nicobar Islands, India. In H. Ota, Tropical Island Herpetofauna: Origin, Current Diversity and Conservation (pp. 43-77). Amsterdam: Elsevier Science B. V.*
- Das, I (1999b) *A noteworthy collection of mammals from Mount Harriet, Andaman Islands, India. Journal of South Asian Natural History*, 4:181-185.
- Dutta, S K (1997) *Amphibians of India and Sri Lanka (Checklist and Bibliography). Bhubaneswar: Odyssey Publishing House.*
- Glaw, F & Vences, M (2007) *Field Guide to the Amphibians and Reptiles of Madagascar. Third Edition. Koln: Verlag.*
- Harikrishnan, S, Vasudevan, K, & Choudhury, B C (2010) *A review of herpetofaunal descriptions and studies from Andaman and Nicobar Islands, with an updated checklist. In Ramakrishna, C. Raghunathan, & C. Sivaperuman, Recent Trends in Biodiversity of Andaman and Nicobar Islands (pp. 387-398). Kolkata: Zoological Survey of India.*
- Khan, M S (1996) *The oropharyngeal morphology and feeding habits of tadpole of Tiger frog Rana tigerina Daudin. Russian Journal of Herpetology*, 2: 163-171.
- Lever, C. (2001). *The cane toad: the history and ecology of a successful colonist. Otley, West Yorkshire, UK: Westbury Academic and Scientific Publishing.*
- Savidge, Julie A (2008) *Extinction of an island forest avifauna by an introduced snake, Ecology*, 68: 660-668.
- Simberloff, D & Rejmanek, M (2010) *Encyclopedia of biological invasions, University of California Press, California.*

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Banning squirrels from the pet trade in Italy

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In the last decades, the role of the intentional importation in the introduction of alien mammals into Europe has grown significantly, and at present the intentional release or the escape from containment facilities is the most common cause of introduction of mammals accounting for 35% of introduction events in the region (Genovesi et al. 2009). The importance of pets and escapes from zoos is even more important if we consider particular groups of mammals. Squirrels (Sciuridae) are considered a family with many highly invasive species. In a recent review, Bertolino (2009) collected information on 248 events of squirrel introductions, which occurred worldwide from 1876 to 2006, with 20 species involved. The introduction pathway was known in 174 events; in 92.5% of cases the squirrels were animals from the pet trade that were deliberately introduced, while, in the remaining 7.5%, the animals escaped from zoos and private facilities. After the release even of few squirrels, there is a high probability of establishment and in 200 cases (80.6% of the events), 18 species (90% of introduced species) were considered to be establi-

shed and showed a range and population expansion. After their establishment, many species produced impacts to biodiversity and human activities (forestry, agriculture, and damage to technical installations); furthermore, they can carry diseases that may affect humans as well as native species (Wood et al. 2007; Bertolino 2009; Bertolino & Lurz 2013). In fact, squirrels have an innate appeal to humans and can be easily found in pet shops. For this reason, the pet trade must be considered a high-risk pathway for new introductions, and preventive actions should therefore focus on public education and on a legal framework that consider also trade restrictions for the squirrel species.

From what we know, all the 26 introductions of the four alien squirrel species present in Italy are due to pet trade (at least 20 grey squirrel introductions and three *Eutamias sibiricus*, two *Callosciurus finlaysonii*, and one *Callosciurus cfr. erythraeus* introductions, Bertolino & Genovesi 2005; Bertolino 2008; Martinoli et al. 2010; Bertolino et al. in press). Till 2012, alien squirrels were freely traded in Italy, and this is very likely the reason of the periodical recording of new sites of presence of these species. It is therefore evident that no eradication or control effort can permanently resolve the threats posed by alien squirrels without the simultaneous adoption of a trade ban

The importance of the pet-trade pathway and the invasiveness of squirrels are well known among scientists. During the 6th International Colloquium on Arboreal Squirrels, held in Kyoto City, Japan, on 4-8 February 2012, squirrel experts from 9 countries and 3 continents discussed the problems related to the introduction of squirrel species and unanimously approved a resolution with four points⁽⁴⁾: 1) The pet trade must be considered a high-risk pathway for new squirrel introductions with concomitant threats and impacts on biodiversity, agriculture and forestry. Thus, the resolution urges Governments and international bodies to prevent new introductions, through the adoption and enforcement of stricter rules on import, trade and possession of squirrel species. 2) The resolution calls the decision maker to urgently ban the pet trade of squirrel species. Squirrel experts consider that 3) small populations of introduced squirrel species must be promptly eradicated to avoid their spread, while 4) a permanent targeted population control programme may be the only alternative to inaction and the ac-



The brochure of the LIFE project

ceptance of significant ecological and economic consequences in case of large populations.

The international trade of three invasive squirrel species (the American Eastern grey squirrel *Sciurus carolinensis*, The American fox squirrel *Sciurus niger* and the Asiatic Pallas's Squirrel *Callosciurus erythraeus*) is now suspended in the European Union (EU). The three squirrel species were included in year 2012 by EU in a list of species whose introduction (i.e. international trade) is suspended on the basis of the evidence that they constitute an ecological threat to EU biodiversity. This list is an implementation of the CITES regulation and is directly applicable in all Member States. Other species already included in the list are two sliders *Trachemys scripta elegans*, and *Chrysemys picta*, a frog *Rana catesbeiana*, and a duck *Oxyura jamaicensis*. The regulation suspends the introduction into the Union of specimens of certain species of wild fauna and flora⁽²⁾ and requires a documentation for the movement of specimens already present (or born in captivity) in European countries.

In Italy the limitation is now even more stringent. A decree signed on 24th December 2013 by the Ministers of the Environment, Agriculture and Economic Development and published on 2nd February 2013 forbids trading, raising and keeping the three squirrel species⁽³⁾.

The decree is one of the first important result of the European EC-SQUARE LIFE+ Project: "Eradication and control of grey squirrel: actions for preservation of biodiversity in forest ecosystems" started in September 2010. The main objective of EC-SQUARE is to eliminate (or reduce) the risks posed by the grey squirrel introduced into Italy. The grey squirrel is a North American species that has been introduced into a lot of localities in North America, Australia, South Africa, and Europe, into Great Britain, Ireland and Italy (Gurnell & Pepper 1993; O'Teangana et al. 2000; Martinoli et al. 2010). The spread of the grey squirrel in these European countries has been associated with a dramatic decline of the native red squirrel, the only tree squirrel in Europe. This replacement is caused by competition for food resources between the two species that reduces juvenile body growth and recruitment, and female breeding success in the red squirrel (Wauters et al. 2002a, b; Gurnell et al. 2004). In UK and Ireland the replacement is also disease-mediated, as grey squirrels act as a reservoir host to a squirrel poxvirus that causes a high mortality in red squir-

rels (Tompkins et al. 2002; Rushton et al. 2006). The spread of the grey squirrel beyond the Italian border would represent a serious threat for the survival of the red squirrel in the long term at a European scale (Tattoni et al. 2006; Bertolino et al. 2008).

The starting of the LIFE-funded project with the aim to control or eradicate the grey squirrel in North Italy and the recent trade ban of grey squirrels are the first actions aiming to reduce the risk for the conservation of the red squirrel.

Building a European strategy on invasive species, we must consider that the availability in pet shops of exotic species that may threaten native species represents a high-risk pathway for new invasive introductions. Intentional releases or the escaping risk should be considered very probable. Therefore the management of this risk should include the regulation of pet trade with the ban of species that are considered or suspected to be potentially invasive.

Acknowledgements

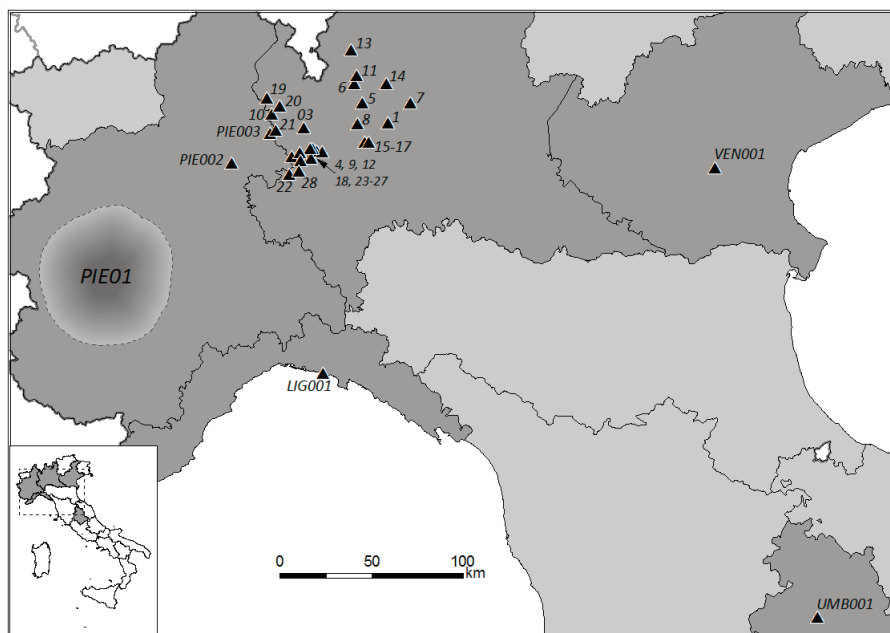
This work was achieved under the LIFE09 NAT/IT/000095 EC-SQUARE Project (www.rossoscoiattolo.eu/en). This is paper no. 2 of the EC-SQUARE project.

References

- Bertolino S (2008) Introduction of the American grey squirrel (*Sciurus carolinensis*) in Europe: a case study in biological invasion. *Curr Sci* 95:903-906
- Bertolino S (2009) Animal trade and non-indigenous species introduction: the world-wide spread of squirrels. *Divers Distrib* 15:701-708
- Bertolino S, Genovesi P (2005) The application of the European strategy on invasive alien species: an example with introduced squirrels. *Hystrix* 16:59-69
- Bertolino S, Lurz PWW (2013) *Callosciurus* squirrels: worldwide introductions, ecological impacts and recommendations to prevent the establishment of new invasive populations. *Mammal Rev* 43:22-33
- Bertolino S, Lurz PWW, Sanderson R, Rushton S (2008) Predicting the Spread of the American Grey Squirrel (*Sciurus carolinensis*) in Europe: a Call for a Co-ordinated European Approach. *Biol Cons* 141:2564-2575
- Bertolino S, Cordero di Montezemolo N, Preatoni DG, Wauters LA



Fig. 1. Italian grey squirrel colonies (reproduced from Martinoli et al. 2010)



Martinoli A (in press). A grey future for Europe: *Sciurus carolinensis* is replacing native red squirrels in Italy. *Biol Invas* DOI: 10.1007/s10530-013-0502-3

Gurnell J, Pepper H (1993) A critical look at conserving the British red squirrel *Sciurus vulgaris*. *Mammal Rev* 23:125-136

Gurnell J, Wauters LA, Lurz PWW, Tosi G (2004) Alien species and interspecific competition: effects of introduced eastern grey squirrels on red squirrel population dynamics. *J Anim Ecol* 73:26-35

Martinoli A, Bertolino S, Preatoni DG, Balduzzi A, Marsan A, Genovesi P, Tosi G, Wauters LA (2010). Headcount 2010: The multiplication of the grey squirrel populations introduced in Italy. *Hystrix* 21:127-136

O'Teangana D, Reilly S, Montgomery WI, Rochford J (2000) Distribution and status of the red squirrel (*Sciurus vulgaris*) and grey squirrel (*Sciurus carolinensis*) in Ireland. *Mammal Rev* 30: 45-56

Rushton SP, Lurz PWW, Gurnell J, Nettleton P, Bruemmer C, Shirley MDF, Sainsbury AW (2006) Disease threats posed by alien species: the role of a poxvirus in the decline of the native red squirrel in Britain. *Epidem Infect* 134:521-533

Tattoni C, Preatoni DG, Lurz PWW, Rushton SP, Tosi G, Martinoli A, Bertolino S, Wauters LA (2006) Modelling the expansion of grey squirrels (*Sciurus carolinensis*) in Lombardy, Northern Italy: implications for squirrel control. *Biol Invasions* 8:1605-1619

Tompkins DM, Sainsbury AW, Nettleton P, Buxton D, Gurnell J (2002) Parapoxvirus causes a deleterious disease in red squirrels associated with UK population declines. *Proc R Soc, Lond B* 269:529-533

Wauters LA, Gurnell J, Martinoli A (2002a) Interspecific competition between native Eurasian red squirrels and alien grey squirrels: does resource partitioning occur? *Behav Ecol Sociobiol* 52:332-341

Wauters LA, Tosi G, Gurnell J (2002b) Interspecific competition in tree squirrels: do introduced grey squirrels (*Sciurus carolinensis*) deplete tree seeds hoarded by red squirrels (*S. vulgaris*)?. *Behav Ecol Sociobiol* 51:360-367

(1) http://www.rossoscoiattolo.eu/sites/default/files/documenti/resolution_from_the_6th_international_colloquium_on_arboreal_squirrels.pdf

(2) <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:223:0031:01:EN:HTML>

(3) <http://www.rossoscoiattolo.eu/en/news/finally-interministerial-decree-protection-red-squirrel>

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Michel Pascal

4 OCTOBER 1947 - 5 JANUARY 2013

A few years ago, I participated to a short mission on an uninhabited island, in the middle of which stood the crumbled remains of an old fortress. Pushed by a mischievous sense of adventure, Michel Pascal and I decided to spend the night in the darkness of the second underground level. Twenty feet belowground, Michel taught me how to climb – and remain – in my very unstable, one-string hammock, and lulled me to sleep with his joyful, amazing stories, well into the pitch-dark night. More than his numerous scientific qualities and achievements, I will remember him for his kindness, his modesty and his unflinching sense of humor.

Michel Pascal was known by all as “El Ratator” and had the look of a Santa Claus disguised into Indiana Jones. Or the other way around. Like all good scientists, he was deeply passionate and enthusiastic, insatiably curious, ever rigorous, cleverly eclectic and profoundly knowledgeable.

His expertise on biological invasions had made him a most appreciated expert of introduced rodents and invaded insular ecosystems. But before that, he had studied many organisms – from algae to sea elephants – on many islands, from the subantarctic Kerguelen to the tropical Clipperton, and from the metropolitan archipelagos of Brittany to those of New Caledonia. As a result, this excellent naturalist was a rare mine of knowledge that spanned from biology and evolution to history and paleontology. He was able to mark tens of thousands of animals as well as use genetics and biomolecular methods to answer a large range of questions of population dynamics and evolutionary ecology. El Ratator was one of the very few scientists with the qualitative qualities of the previous generation to have successfully stepped into our frantic era of quantitative and fast-paced research. The resulting mix was of course outstanding.

His numerous achievements included the eradication of small mammal populations from 75 islands and archipelagos, the publication of over a hundred articles and books, the dissemination of knowledge to school pupils as well as PhD students and even the participation for France to the 1983 moratorium on the commercial hunting of whales. A busy and fruitful life. The fifth of January 2013, El Ratator passed away, at age 65. He left behind a wife and two children, now working in fields of biological conservation and marine research, an undeniable testimony to his exceptional pedagogic and human qualities. His friends and colleagues have also been deeply affected by this loss, but the character was such, that grief and sorrow are gradually getting replaced by fond memories and happy anecdotes. He brought much to conservation biology, to science and to the world.

Ratator was unique, exceptional, yet he was not alone in his case. My thoughts also go to all of you Catators, Weedators and other Buggators out there. Your achievements are meaningful and valuable. Thank you for caring, so passionately; thank you for making a difference.



Michel Pascal, saluting from Tahiti, French Polynesia, 2009

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Francesca Gherardi

12 NOVEMBER 1955 – 14 FEBRUARY 2013



Francesca Gherardi was an Associate Professor at the Department of Biology, University of Florence, Italy, specializing in the ecology, ethology, and systematics of decapod crustaceans, especially crayfish. She passed away in Florence, at the age of 57 after nobly bearing for three years the onslaught of cancer.

In 32 years of active research, Francesca wrote over 220 scientific articles and scores of book chapters. She produced two seminal volumes on aquatic invasions: "Crayfish in Europe as Alien Species. How to make the best of a bad situation?" with co-editor David Holdich (1999); and "Biological Invaders in Inland Waters: Profiles, Distribution, and Threats" (2007). Both publications arose from international workshops she organized in Florence. These volumes are an essential basis for the study of freshwater invasions in Europe. She was elected Secretary-treasurer (2000-02) and President (2004-06) of the International Association of Astacology (IAA), and she was the recipient of the IAA's "Distinguished Astacologist" award in 2010 for her achievements.

In 1979, she received her "Laurea," the equivalent to a M.Sc. degree, for her thesis entitled "Aggressiveness, dominance hierarchies and individual recognition in decapods." This was followed in 1987 by a Ph.D. in Animal Biology (Ethology) from the University of Florence for her research on the eco-ethology of freshwater crab *Potamon fluviatile*. In the following de-

cade, Francesca travelled widely, spending months at a time on a succession of research fellowships in Kenya and the Maldives, to Australia and the U.S.A, studying mangrove crabs, Indian Ocean pagurids, and the eco-ethology of *Procambarus clarkii* and *Cherax tenuimanus*.

During these active years Francesca published extensively as well as served as a reviewer for some 107 journals: from 'Acta Adriatica' to 'Zoology' and in 1995 she assumed duties as an Associate Editor of the Journal of Crustacean Biology, where she served until her death. In 1992, she was appointed researcher in her alma mater, the Department of Biology of the University of Florence, where over the past two decades she supervised 32 M.Sc. and 10 Ph.D. students.

In recognition of her scientific contributions she was much sought as a member of international bodies, becoming a member of the 'Invasive Species Specialist Group' (ISSG), IUCN Species Survival Commission (SSC), and the Freshwater Crab and Crayfish Specialist Group, IUCN, as well as nominated IUCN expert for the compilation of the Red List of Mediterranean region freshwater crabs and crayfish. Francesca was instrumental in the preparation of several crayfish entries in the IUCN Red List of Threatened Species.

Francesca was widely acknowledged for the depth and extent of the body of research work, but was beloved for her joy of life and sunny disposition. Her scientific legacy, as manifested in publications and the young researchers she taught, attest to a life well lived.

Acknowledgements

Thanks are extended to Roberto Pieraccini for sharing some of his memories and obtaining the photograph from Francesca's files.

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NEW PUBLICATIONS

The impacts of invasive alien species in Europe

In the context of the continued support provided to the European Commission in its efforts to develop an EU legislative instrument to deal with the problem of biological invasions, the European Environment Agency (EEA) has published two reports focusing on IAS impact and relevant indicators:

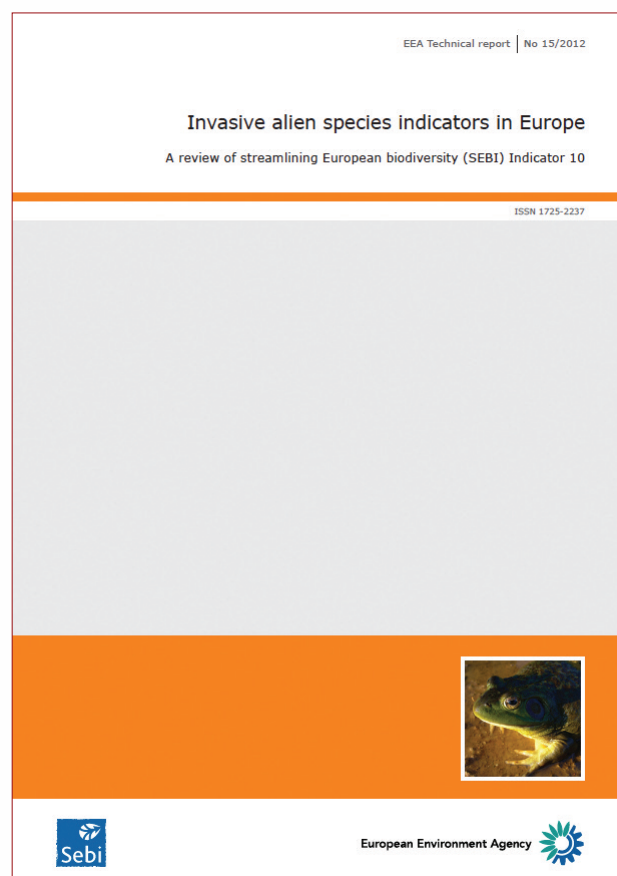
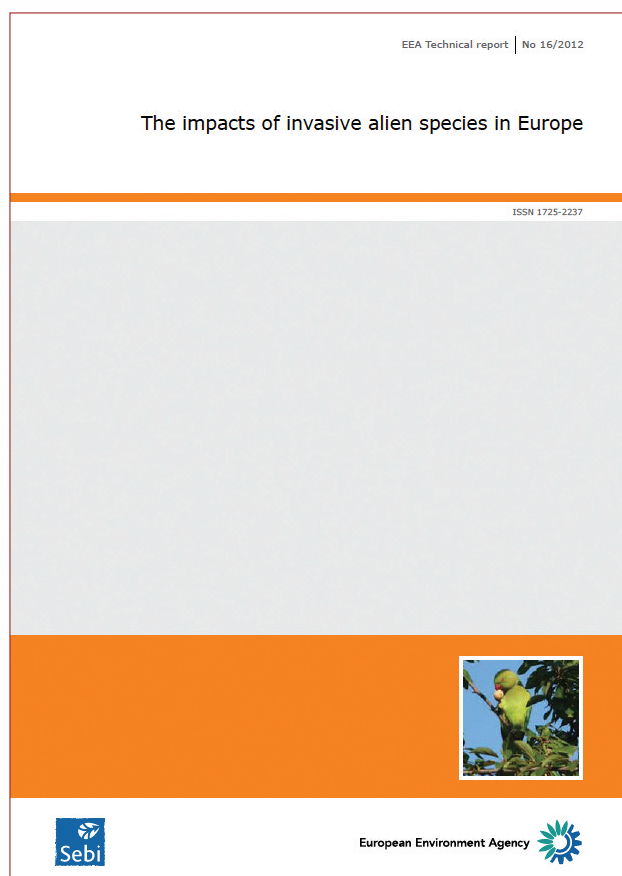
- The impacts of invasive alien species in Europe
- Invasive alien species indicators in Europe - a review of Streamlining European Biodiversity (SEBI) Indicator 10

Both reports have been realised by a multinational team of experts in collaboration with the IUCN/SSC Invasive Species Specialist Group (ISSG).

EEA report on “The impacts of invasive alien species in Europe” includes a description of the multifaceted impact of 28 alien species selected among those known to cause signifi-

cant harm to biological diversity, socioeconomic values and human health in Europe. The report is organised on the basis of the different types of impact by IAS, focusing on competition, predation and transmission of diseases, on IAS affecting human healths and ecosystem services affected, and on IAS making extensive damage to infrastructures, landscape, and agriculture. The species selected as example encompass a diverse range of groups that threaten European freshwater, brackish water, marine and terrestrial environments. The report was launched at the Biodiversity's Ticking Time Bomb event organised at the European Parliament in 2012 by IUCN and BirdLife, with the support of the European Habitats Forum. It received an excellent media coverage of 430 reports (including from the BBC, The Guardian, Reuters, Scientific American etc.) within 24 hours.

The report “Invasive alien species indicators in Europe - a review of Streamlining European Biodiversity (SEBI) Indicator 10” shows patterns and trends of biological invasions, and aims at contributing to raising public awareness of the bio-



logical, ecological and socio-economic impacts of IAS. This report was commissioned by the EEA to support the “Streamlining European 2010 Biodiversity Indicators” (SEBI 2010) process, and particularly to revisit and further develop the indicator “Invasive alien species in Europe”. The aim was to critically review and improve this indicator, and propose an updated methodology. Further, options for methodologies of new indicators, which monitor IAS over time across Europe, are discussed. Particular attention is given to closely linking the proposed indicators to the recent biodiversity policy goals and developments.

The two reports are available online here:

<http://www.eea.europa.eu/publications/impacts-of-invasive-alien-species>

<http://www.eea.europa.eu/publications/streamlining-european-biodiversity-indicators-sebi>

Alien species in Norway

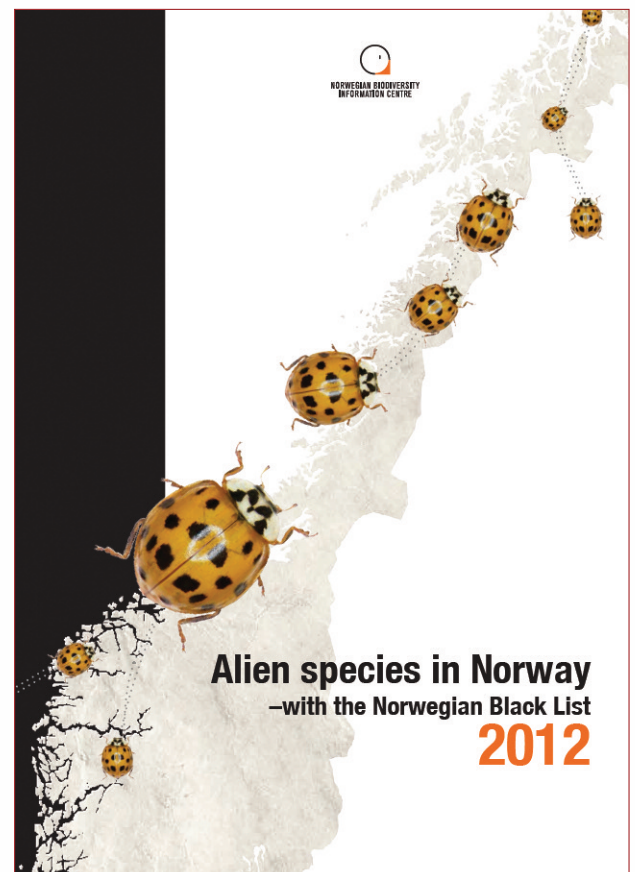
A new semi-quantitative method that enables researchers and others to assess the environmental impacts posed by alien species has now been implemented in Norway. While the method is tailored to the Norwegian environment, it can easily be adapted to other countries, and fills an international need for a quantifiable, uniform approach to classifying and assessing alien species. The publication that details the potential impacts of alien species in Norway “Alien species in Norway – with the Norwegian Black List 2012” presents an overview of ecological impact assessments of alien species which reproduce in Norwegian territories.

The assessments are based upon a new and semiquantitative set of criteria, where the species’ invasion potential and ecological effect are considered. The work has been carried out by 11 groups of experts who have treated ca. 2500 species. Impact assessments have been made for 1180 alien species which reproduce in Norwegian territories and for 134 species which might arrive in Norway with the aid of humans in the future –so called ‘door knockers’. A total of 106 species are categorised as having a severe impact, 111 species as having a high impact, 198 species as having a potentially high impact, 399 species as having a low impact, and 366 species as having no known impact in Norwegian nature.

In addition, species information has been gathered for 1071 alien species which do not reproduce on the Norwegian mainland and territorial waters, and 69 non-reproducing alien species observed in Svalbard.

You can read more about the work and download the PDF of the report here:

<http://www.biodiversity.no/ArticleList.aspx?m=34&amid=12049>



EVENTS

2nd International Congress on Biological Invasions (ICBI 2013)

23-27 October 2013

Qingdao - China

Invasive alien species (IAS) are considered to be one of the most serious challenges to humankind, biodiversity and the environment in the 21st century. In response to the global challenge of IAS, the 1st ICBI (<http://www.icbi2009.org/>) was successfully held on 2-6 November 2009 in Fuzhou, Fujian Province, China with more than 500 participants from 44 countries. It developed a strong network of expert scientists and concluded with unanimous support for the "Fuzhou Declaration". It was agreed that the ICBI would be held on a regular basis, at 4-year intervals. An International Expert Committee has been established to provide scientific, technical and policy guidance to make ICBI a stimulating forum for information exchange and innovation ideas for basic research on and management of IAS.

Supported by the International Expert Committee, and organised in partnership with ISSG, the 2nd ICBI will continue to facilitate the exchange of cutting edge research and the tracking of technical progress on managing IAS eco-rationally and sustainably. The Congress will also address the gaps between research and field applications, key links between biological invasions, biodiversity and ecological safety, as well as the relationships between climate change and biological invasions. You can find additional information here:

<http://www.icbi2013.org/web/index.aspx>

4th International Symposium on Weeds and Invasive Plants

18-23 May 2014

Montpellier - France

The international symposium « Agricultural Weeds and Plant Invaders» was initiated in 2006 and takes place once every three years in a European country (Portugal in 2006, Croatia in 2008, and Switzerland in 2011). This event brings together scientists and managers who share a strong interest in the Biology, Ecology and methods of controlling invasive plants in cultivated and natural habitats as well as urban areas.

The next conference to be held in Montpellier will be a great opportunity to survey the ongoing research that is blossoming inside and outside of Europe (with a venue of invited conference speakers). Montpellier and the surrounding region are hosts of many different research teams working in the domains of agronomy, biodiversity, ecology and biological control and which belong to a variety of French and foreign research agencies. The expected audience will bring together the principal participants in research, higher education, governmental services and development agencies that deal with the management of weeds and invasive plants.

The Objectives of the 4th symposium are:

- Strengthening interactions between all fields for the management of invasive plants (e.g., ragweed) by facilitating exchanges between the researchers in basic and applied research, and managers and action agencies in the field.



- Broadening the scope of this conference to include the entire Mediterranean basin where the agronomical and environmental concerns are similar those of the southern Europe.
- Bridging the fields of invasion biology science and social and human sciences

You can find additional information here:
www.ansespro.fr/invasiveplants2014/
<http://invasive.weeds.montpellier.ewrs.org>

Conference Non-indigenous species in the North-East Atlantic **20-22 November 2013** **Ostend - Belgium**

The introduction of non-native species is often linked to a threat to the local biodiversity. Several guidelines and policy pay already attention to this (OSPAR, ICES, the European Marine Strategy Framework Directive, the IMO Ballast Water Convention).

What are the reasons of their success in our regions, what are their vectors, what is their impact and how do we best deal with these species? To bring policy and science together ILVO organizes, in cooperation with Vliz, Museum (MUMM) and UGent, the conference "Non-indigenous species in the North-East Atlantic". Open for scientists, policy makers/advisors, academics and stakeholders.

Non-indigenous species are an important aspect within new coming regula-



tions amongst them MSFD-Marine Strategy Framework Directive. Many questions like "why do these species survive here as well?"; "how do they get here?"; "what is their impact and how do we deal with it?" will be highlighted. Scientists and policymakers will be brought together to share knowledge and discuss on this.

For registration, further details and regularly updates on the conference see: <http://www.ilvo.vlaanderen.be/nisconference2013>

16th Australasian Vertebrate Pest Conference

26-29 May 2014 - Brisbane Queensland - Australia

The Australasian Vertebrate Pest Conference is a not-for-profit event held every three years to bring together researchers, land managers, students and policy makers dealing with pest animals. The 16th Australasian Vertebrate Pest Conference will be held at the Pullman King George Square, in the CBD of Brisbane, Queensland 26-29 May 2014. The last time the conference was held in Queensland was 1987.

The Conference is proudly hosted by Biosecurity Queensland (part of the Queensland Department of Agriculture, Fisheries and Forestry) and supported by the Queensland Weed Society. The 2014 conference will incorporate the Queensland Pest Animal Symposium, a biennial conference aimed at those interested in pest animal management issues of particular relevance to Queensland. The Queensland Weeds Society is a proud supporter of the Queensland Pest Animal Symposium and will continue this association through support of the 16th Australasian Vertebrate Pest Conference.

The aim of the conference is to bring people involved in pest animal research and management together from Australasia and elsewhere, to network with other like-minded people, including, but not limited to:

- Researchers and students involved in pest management
- State government agencies
- Federal and international government agencies
- Local government pest officers and councillors

- Landowners and Managers
- Natural Resource Management bodies
- Members of conservation agencies and Industry bodies
- Contractors and community project officers

Ample time will be scheduled for networking and discussion during breaks in the scientific program and during the social program, which will include a Welcome Reception and Conference Dinner.

It is anticipated that 200-300 delegates will attend over the three days of the conference.

The conference program will consist of presentations on control initiatives, innovations in research, management and policy and the latest research outcomes. The conference will focus on *Management of vertebrate pest animals across the landscape*.

You can find additional information here: www.avpc.net.au/



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