Topic 6: Dealing with alien invasive species

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Dealing with Alien Invasive Species – Introduction, Overview and Conclusions

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Introduction

Since the invasive species session at the Bermuda conference (Cheesman *et al.*, 2003), a number of important developments have occurred in relation to invasive species in the UKOTs and more widely. Of particular note, a review and database now exist which summarise baseline information on non-native species in the UKOTs (Varnham, 2006; see Varnham & Fleming, this volume). In addition, the UK Government has published a review of policy on non-native species (Defra, 2003). Although this review confines its attention to Great Britain, its recommendations are more widely applicable. The key recommendations of the review were that the UK Government should:

1. Designate or create a single lead organisation to co-ordinate and ensure consistency of application of non-native species policies across Government;
2. Develop comprehensive, accepted risk-assessment procedures to assess the risks posed by non-native species, and identify and prioritise prevention actions;
3. Develop (with the participation of stakeholders in all relevant sectors) codes of conduct to help prevent introductions;
4. Develop a targeted education and awareness strategy involving all relevant sectors;
5. Revise and update existing legislation to improve handling of invasive non-native species issues;
6. Establish adequate monitoring and surveillance arrangements for non-native species;
7. Establish policies and capacity to manage and control invasive non-native species currently present or newly arrived in the wild
8. In developing policies and actions, engage with stakeholders through a mechanism such as a consultative forum.

Moore (this volume) summarises steps towards implementation of the first of these key recommendations.

Relevant regional projects are also underway, either focused specifically on UKOTs (the *Increasing regional capacity to reduce the impacts of invasive species on the South Atlantic UKOTs* project – see Box 1) or more broadly (CAB International's *Mitigating the threats of invasive alien species in the insular Caribbean* project – see Box 2), although the extent to which UKOTs will be able

Box 1. Increasing regional capacity to reduce the impacts of invasive species on the South Atlantic UKOTs

Alien species can now be regarded as the greatest threat to biodiversity in the South Atlantic UKOTs. Non-native rodents, invasive plants and feral cats are amongst the key challenges. Following discussions at the Bermuda conference and within UKOTCF, work started on the development of a proposal to support a regional project to address invasive species threats across the South Atlantic Territories. After some three years of hard work, EU funding was finally secured and the project got underway in late 2006.

The project involves all five UKOTs in the South Atlantic (St Helena, Ascension, Tristan da Cunha, the Falkland Islands and South Georgia & the South Sandwich Islands) with two principal NGO partners (Falklands Conservation and the St Helena National Trust). St Helena is the lead government for the project, which is being implemented by the RSPB. The overall objective is to conserve native biodiversity, and therefore enhance economic prosperity and quality of life for people living on the South Atlantic Overseas Territories

Although the approach of the project is regional, enhancing the potential for co-operation on common challenges, it is clear that each of the five UKOTs has unique characteristics; consequently, cross-sectoral Steering Groups are being formed in each Territory. Baseline information on non-native species, and the systems and capacity in place to deal with species invasion threats, is being collated. This will inform the work of Steering Groups in developing action plans and identifying key issues to be taken forward by the project. Anticipated next steps will involve (according to local priorities):

- Building capacity (enhancing training and local employment opportunities where possible);
- Enhancing infrastructure and systems (e.g. quarantine facilities);
- Eradication/control of key species;
- Awareness raising activities;
- Fund raising for longer-term work.

In the longer term, it is planned to hold a regional conference, develop a regional strategy and early warning system, produce a range of facilitating materials, and maintain and develop contact with other regional initiatives of this kind.

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to participate in the latter still requires clarification. Colleagues in the French Committee of the IUCN have also been developing an initiative on invasive alien species for the French overseas territories (see Palasi & Soubeyran, this volume). A number of Territory-focussed projects on invasive species in the UKOTs are also underway (see summary papers in these Proceedings and recent issues of *Forum News*).

The general literature on invasive species has also been growing. Regional reviews of various kinds have included those for the Caribbean (Kairo *et al*. 2003a, b; Lopez & Krauss 2006), the Austral-Pacific (Shine *et al.* 2003a, b), the Western Indian Ocean (Mauremootoo 2003), South and Southeast Asia (Pallewatta *et al.* 2003a, b), Southern Africa (Macdonald *et al.* 2003a, b), Western Africa (CAB International 2004) and South America (Ziller *et al.* 2005a, b). New books have been published, for example, on pathways and vectors (Ruis & Carlton 2003), species invasion ecology (Sax *et al.* 2005), management of marine invasives (Hilliard 2005), and reviewing the first phase of the Global Invasive Species Programme (GISP) (Mooney *et al.* 2005). Materials and information available on the Internet have also been growing. A recent Google search on 'alien invasive species' resulted in >1.3 million hits! Useful online resources include those provided by The Global Invasive Species Programme (www.gisp.org), the Invasive Species Specialist Group (www.issg.org) and the CBD website (www.biodiv.org/programmes/cross-cutting/alien). For further details on general information sources like these, see Cheesman *et al.* (2003).

Since the Bermuda conference, discussions on invasive species in the UKOTs have tended to focus on the need for mechanisms to prioritise projects (e.g. see Varnham 2006, Annex 2, Section 2). Whilst many of the factors to be considered in building invasive species management infra-

Box 2. Mitigating the threats of invasive alien species (IAS) in the insular Caribbean

Several major species invasions in recent years (e.g. the introduction and rapid spread of the Pink Hibiscus Mealybug *Maconellicoccus hirsutus*) have served to emphasize the regional nature of threats from IAS in the Caribbean. Such invasions pose a significant potential threat to agriculture in the region, as well as to the endemic-rich biodiversity of the Caribbean islands (Kairo *et al.* 2003b). It has been recognised that a region-wide response to the IAS problem is essential in order to maximize benefits from the limited and often scarce resources available. Building on a preliminary assessment of invasive species threats in the Caribbean carried out by CABI in 2002/3 (Kairo *et al.* 2003a), a major regional initiative was designed, based around the following components:

- Development of national IAS strategies;
- Caribbean-wide cooperation and strategy;
- Information and knowledge generation, management and dissemination;
- Prevention of species invasions in terrestrial, freshwater and marine systems;
- Early detection of, rapid response to, and control of, IAS impacts in terrestrial, freshwater and marine systems.

A network of regional partners was established, national consultations were undertaken, and GEF funding was obtained for the initial (PDF-A) phase of the initiative. This supported a regional workshop held in Trinidad & Tobago in January 2007, which refined objectives and arrangements for the overall initiative. In parallel with these activities, CABI also undertook a review of marine invasive species issues in the Caribbean (Lopez & Krauss 2006).

A proposal for the second (PDF-B/PPG) phase of the project has now [September 2007] been submitted to GEF, with implementation anticipated during late 2007 and 2008. The full-scale project arising from the initial phases is anticipated for the period 2008-2012. CABI has always been keen that the Caribbean UKOTs should be involved in this regional initiative, but it is not possible to use GEF funding to support their participation. Unfortunately, a proposal to facilitate their involvement under the fourth round of OTEP was unsuccessful, but efforts to identify resources for UKOT participation continue.

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structure are fairly clear (see below), their relative importance for any given Territory will inevitably be determined by the local situation. Similarly, the priority attached to short-term control/eradication projects will be substantially influenced by context-specific factors. It is possible, therefore, that a straightforward, universal mechanism for prioritising projects cannot be developed. Discussions during the Dealing with Alien Invasive Species session at the Jersey conference focussed on general considerations in relation to the prioritisation of projects.

Session Overview and Conclusions

A fundamental requirement for assessing priorities for the management of invasive species threats is baseline information on:

1. Invasive species themselves - those non-native species which are present in, or likely to be introduced into, any given Territory; the actual/potential impact of those species on biodiversity and/or human endeavours;
2. The infrastructure, in a broad sense, which exists locally for invasive species management - prevention of introduction and establishment, as well as control or eradication (including, for example: the implications of adopting particular control strategies - cf. Parkes, this volume; opportunities for 'mainstreaming' invasive species management activities – cf. Mauremootoo, this topic section of volume).

Information on non-native species in the UKOTs

Varnham (2006) provides a foundation resource for information on non-native species in the UKOTs, and there is much potential for enhancing the database produced under this review. Opportunities should be taken to fill existing gaps and to develop the database as a baseline resource. Potential refinements include clearer categorisation of the species listed, e.g. according to the level of threat that they pose in each Territory. Currently, the database includes apparently benign non-native species, as

well as invasive ones (i.e. those that have spread rapidly with negative consequences).

Information on infrastructure for invasive species management in the UKOTs

In most cases, information on the infrastructure which exists for management of invasive species is yet to be collated. However, for example, a recent report on *Biosecurity for the Falkland Islands* includes an important review of infrastructure, as well as key pathways for species introductions. Similar exercises are likely to be conducted for other South Atlantic UKOTs under the project described in Box 1.

Whilst detailed information on infrastructure may currently be lacking for most UKOTs, a range of sources indicate the typical, key features of such infrastructure. These illustrate the breadth and diversity of components that need to be considered when assessing, identifying gaps in, and ultimately enhancing the invasive species management infrastructure. Examples of relevant sources include: the *CBD Guiding Principles* for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species (CBD 2002); the invasive species components of the CBD Work Plan on Island Biodiversity (CBD 2006); the existing Regional Strategy for invasive species management in the Pacific (Sherley 2000).

The same fundamental elements of infrastructure occur repeatedly in these and other documents on invasive species management (see also Table 1 and Figure 1). These are measures to:

- Raise awareness at all levels of society, and across all relevant sectors, including through education programmes;
- Engage all relevant stakeholders in development of policy, management plans etc., and implementation activities;
- Enhance cooperation and communication between relevant sectors and authorities (including within governments);
- Develop and enforce appropriate legislation, voluntary codes of conduct etc.;
- Establish facilities (including technical capacity) for research, monitoring, surveillance and control activities;
- Apply risk assessment to characterise critical vectors, pathways and species;
- Participate in relevant regional initiatives and establish linkages with relevant international instruments.

Importantly, CBD (2002) recognises that implementation of its Guiding Principles is dependent on **availability of resources**. Similarly, Sherley (2000) identifies inadequate funding as a constraint on implementation of the Pacific strategy.

Additional guidance on prioritising invasive species projects

Other key points that have arisen from recent discussions over prioritisation of measures to tackle invasive species in the UKOTs include the following:

1. Priority should be given to the protection and/or restoration of sites of greatest value

This is an obvious principle, but one which is very difficult to apply. Value can be assessed in many different ways, all of which are valid: in biodiversity, economic or social terms, for example. It is also important to remember that a given situation may not be seen in the same way from different perspectives. For example, an ecosystem threatened or afflicted by invasive species may be of relatively little value in a global context, but of very great value to a local community. Both perspectives may need to be considered when assessing whether action to protect or restore that ecosystem is a high priority. In general, however, it is likely that prevention/detection measures will be of highest priority where a threatened ecosystem is in relatively pristine condition, and that control/eradication measures will be of highest priority where a damaging species invasion is already well advanced. It is important to ensure with any control/eradication process that adequate thought and funds are allocated to post-control monitoring to ensure non reoccurrence of the alien species, otherwise scarce funds allocated to the initial control/eradication will have been wasted (cf. Point 4 below).

2. Priority should be given to the most cost effective measures

Prevention is invariably more cost effective than control (e.g. CBD 2002). However, the success of a good prevention programme (i.e. species invasions do not occur) is inevitably less 'visible' than the success of an eradication programme that leads to the removal of a devastating invasive species and facilitates the reversal of its many negative impacts. Thus, money invested in preventing the establishment of invasive species tends not to show the short-term results that are apparent from

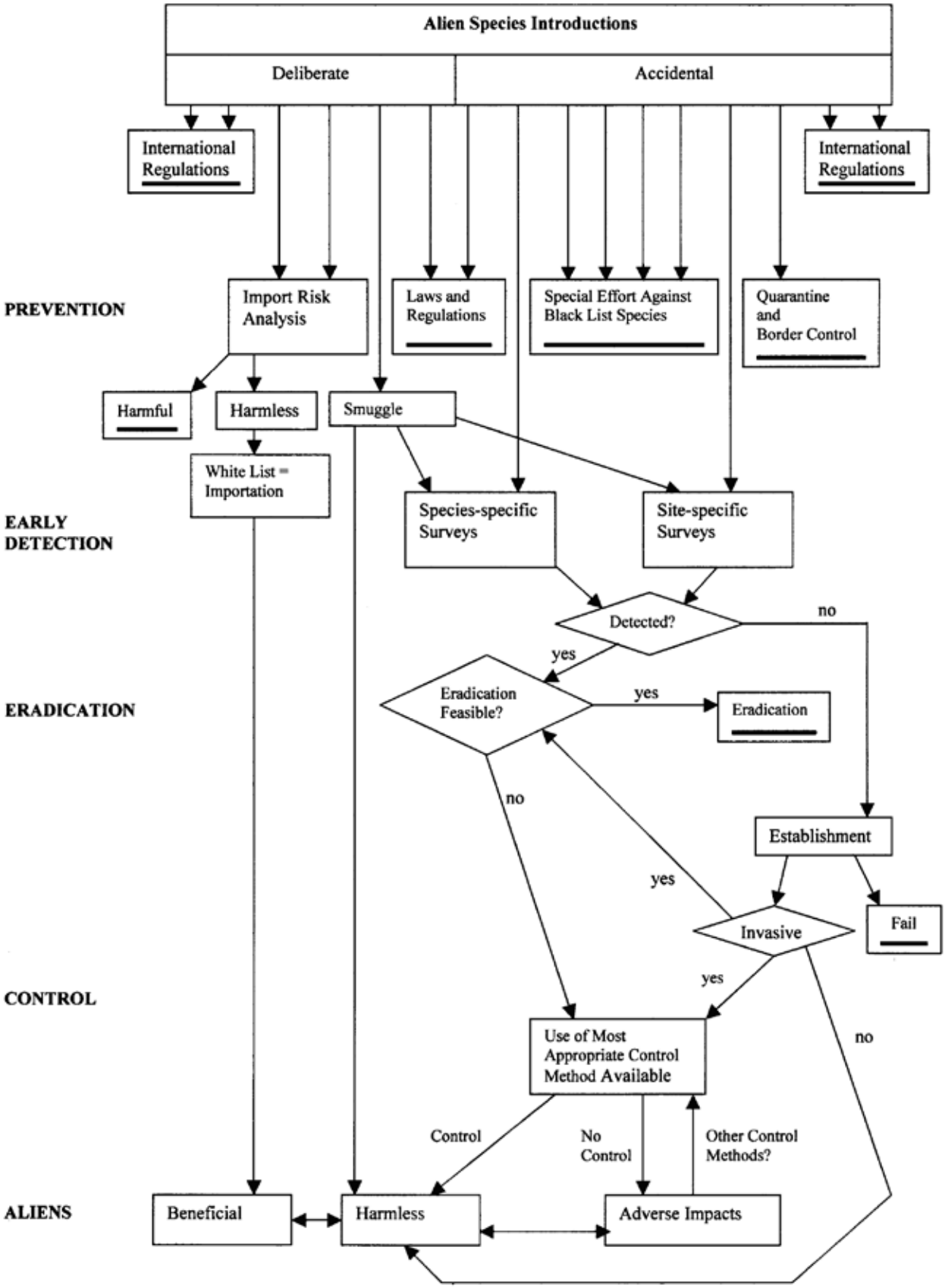

Figure 1. Summary of options to consider when addressing alien species. Black bars mark the potential final stages of introduced alien species. Diamonds symbolise important bifurcations and decision points. From Wittenberg & Cock (2001).

(successful) eradication projects, and investment in prevention may therefore be less attractive to funding agencies despite its greater cost effectiveness (Varnham 2006, Annex 2, Section 2).

	Information/awareness	Prevention/detection	Control/eradication
Strategy	Assess information needs, eg: • baseline data on invasive species already present and their impacts • data on potential invasive species threats • co-operation with regional/international bodies • awareness-raising at all levels of society (practitioners, policy makers, public) • obligations under existing regulations/ legislation Develop strategy to address these needs	Assess prevention needs, eg: • identification of key pathways for introductions • risk assessment • cross-sectoral issues • co-operation with regional/international bodies • obligations under existing regulations/ legislation Develop strategy to address these needs	Assess control needs, eg: • which invasive species already present are a) most damaging and b) have greatest potential for successful control/ eradication? • control or eradicate? • co-operation with regional/international bodies • obligations under existing regulations/ legislation Develop strategy to address these needs
Local capacity	Assess local capacity to address information needs, eg: • who can establish/ maintain databases? • who can undertake/ facilitate awareness-raising activities? Build local capacity to address these needs	Assess local capacity to address prevention needs, eg: • who is responsible for implementation of prevention measures? • what limitations exist to enforcement? Build local capacity to address these needs	Assess local capacity to address control needs, eg: • who can undertake control/eradication programmes? Build local capacity to address these needs
Intervention	Action to address information needs, eg: • establish/maintain databases • build information-sharing networks • undertake awareness-raising activities	Action to address prevention needs, eg: • enhance co-operation between implementation/ enforcement agencies • enhance prevention mechanisms	Action to address control needs, eg: • control/eradication programmes against particular species

Table 1. Aspects of invasive species management projects. This matrix was developed following discussions on prioritisation of invasive species projects at the UKOTCF Wider Caribbean Working Group in 2003. Rather than indicating where priority should be placed, it was intended to illustrate the range of inter-related issues that projects might be expected to consider.

3. Priority should be given to measures which demonstrate a holistic approach, and maximise synergies/linkages with other relevant policies and activities

The many dimensions of the invasive species problem are interlinked – for example, successful prevention or control strategies rely on good co-operation and coordination, which themselves rely on high levels of awareness (cf. Table 1). Key challenges to tackling invasive species in any country arise from the fragmentation of responsibility among different government departments and other stakeholders, and poor communication between different sectors. Hence, measures which enhance co-operation, coordination and communication between individual initiatives, and between stakeholders, are of particular value in efforts to manage the threats and impacts of invasive species.

4. Priority should be given to measures which can demonstrate a high likelihood of success

Projects intended to tackle invasive species issues must be feasible in the short-term and sustainable in the long-term. Increasing experience in the

control/eradication of island invasives (e.g. see Veitch & Clout 2002) suggest that the feasibility of such operations can be assessed, and that many such programmes have a reasonable likelihood of success. However, to ensure that this success is sustained in the longer term, control/eradication programmes should wherever possible also consider measures to restore habitats and prevent re-invasions. This may involve the development of robust prevention and early detection measures, in concert with control activities.

Conclusions

In planning this session, we had hoped to identify ways of prioritising activities in relation to invasive species – not identifying which species were the most important to control (which is relatively straightforward), but in terms of broader, strategic issues. In fact, there is no simple formula for strategic priority setting. However, the session touched on a number of themes that will undoubtedly be amongst key priorities, as outlined above. In planning the next steps, we perhaps need to consider, in particular:

- Enhanced information gathering and information sharing, including development of the database arising from Varnham (2006);
- An audit of measures that are already in place in each UKOT for invasive species management;
- Planning for better co-ordination of activities, within and between UKOTs, and across the regions in which UKOTs are located;
- The development of rapid response mechanisms.

Perhaps the best approach would be for each UKOT to conduct a Needs Assessment in relation to invasive species, perhaps as part of an audit of measures which are already in place. This approach is consistent with the CBD Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species (CBD 2002). Indeed, CBD (2002, Paragraph 10) urges parties to develop National Invasive Alien Species Strategies and Action Plans, possibly as components of National Biodiversity Strategies and Action Plans, as a basis for identifying national needs and priorities in this area.

Post-Jersey conference developments

In June 2007, JNCC hosted a workshop on invasive species in the UKOTs, which brought together a wide range of participants from governments, NGOs and academia. Discussions centred on strategic prioritisation of invasive species projects, regional approaches, development of the UKOTs non-native species database managed by JNCC, and general aspects of the way ahead. Full details of the meeting and its outcomes can be found at http://www.jncc.gov.uk/page-4081, however, the main conclusions were:

Strategic prioritisation of projects

- the lack of mechanisms for strategic prioritisation of projects remains a concern;
- mechanisms for strategic prioritisation must consider impacts on biodiversity and socio-economic elements;
- a working group should be formed to take this issue forward, ensuring direct input from UKOTs;

Regional approaches

- regional approaches provide many potential benefits through the pooling of resources, experience and effort (for example, in relation to awareness raising across sectors);
- a working group should be formed to take this issue forward, initially with focus on Caribbean UKOTs;

UKOTs non-native species database

- gaps remain to be filled in the baseline information held in the database;
- additional functionality should be developed according to the needs of users;
- a working group should be formed to take this issue forward.

In addition, the establishment of a working group to consider aspects of awareness raising and stakeholder engagement was proposed.

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Non-native species in the UK Overseas Territories and Crown Dependencies: outcome of a review

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A review of non-native species was undertaken, based on a desk study of available data and consultation with individual experts, the first time such an exercise had been attempted for the UKOTs and CDs. The resulting report and database provide valuable baseline information, a key resource in addressing invasive species threats, and have been made freely available through the JNCC website. Numbers of non-native species records from each UKOT/CD vary substantially, according to the level of local survey work undertaken. Small numbers of records often indicate lack of survey work rather than absence of non-native species. Filling of information gaps, regular updating and some refinement will be required if the database is to fulfil its potential value as a tool in support of future priority setting and research.

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In 2004 the Joint Nature Conservation Committee commissioned a review of non-native species in the United Kingdom's Overseas Territories (UKOTs) and Crown Dependencies (CDs), the first of its kind (Varnham, 2006). For their size, the UKOTs and CDs contain a disproportionately high number of threatened and endemic species relative to the metropolitan UK. According to the Millennium Ecosystem Assessment (MEA, 2005), invasive species are the biggest threat currently facing the biodiversity of the world's small islands, so gathering baseline information on the nature and scale of this threat is extremely important. This information is a vital first step in assessing the scale of the problem in the UKOTs & CDs and may help, for example, to prioritise which invasive species should be controlled first.

The first phase of the project was a desk study, reviewing the existing literature on invasive species in the UKOTs and CDs. In addition to published material, unpublished reports and papers, many little known outside their particular territories, were a particularly important source of information. In the second phase of the project, the data gathered so far was sent to experts with first hand experience of the UKOTs and CDs in order to validate the existing information and to add further species records. This second phase proved very successful and resulted in the number of species records in the database more than doubling to almost 3000; important additional information was also collated for many of the existing records.

Although the project had initially been conceived to collect information on 'invasive' species, it became apparent early on that, in most cases, there was simply not enough data available to determine whether most species known to be introduced were actually invasive in the ecological sense. There is no single universally recognised definition of what constitutes an invasive species. However, one useful definition is supplied by the IUCN Invasive Species Specialist Group, which characterises them as: species, usually transported by humans, which successfully establish themselves in, and then overcome, otherwise intact, pre-existing native ecosystems. This distinguishes them from species which have formed self-sustaining populations in the wild but do not cause harmful changes to the nature of the ecosystems around them (usually termed naturalised species). Other introduced species, such

as most ornamental plants, may never form self-sustaining populations at all and remain entirely dependent on humans. Since, in most cases, we did not have the information necessary to decide which species were invasive, we made the decision to include all introduced or non-native species, taking the view that it was better to exclude species at a later date, rather than to miss potentially damaging species simply because there was no accessible data on their invasiveness.

The database consists of an Excel spreadsheet with a page for each territory, plus some additional summary pages. The categories of information held within the database were designed to capture the kind of information necessary to determine whether a species was invasive or was likely to become so. Key areas included distribution and rate of spread, including present and potential distribution, routes of entry and modes of transmission within a territory, known and potential ecological impacts and, finally, details of actions taken or planned to tackle the species in each territory. We were also keen to make the information as relevant as possible to people living or working in the UKOTs and CDs by including local common names as well as internationally recognised scientific names. The database and an accompanying report have been sent to all contributors and are also available as a free download through the JNCC website (www.jncc.gov.uk/page-3634).

The bar chart below (Figure 1) shows the number of non-native species recorded from each UKOT and CD. The most striking result is the number of records from Bermuda, for which the database contains records of 1139 non-native species, almost three times as many as St Helena which, at 414, has the next highest number of records. For two regions, the South Sandwich Islands and the Cyprus Sovereign Base Areas, no non-native species were recorded. However, these raw figures probably do not always present an accurate picture of the numbers of non-native species in each territory. A great many records were available to us from a small number of recent pieces of work which had systematically gathered records, namely: Ashmole & Ashmole (2000) for St Helena & Ascension, Mary Walker (pers. comm.) for plants on Anguilla, and Andy Douse (pers. comm.) for the Falkland Islands. Bermuda has recently carried out an island-wide Biodiversity Project, collecting data about all species present there, native and introduced (see Glasspool *et al*. 2000). Invasive species are certainly a serious problem in Bermuda, but the high number of records collected for this territory is due more to this recent in-depth study. A similar pattern underlies all the territories on the left hand side of Figure 1 – in all cases from Tristan da Cunha upwards, the great majority of the records have come from existing systematic collections of data.

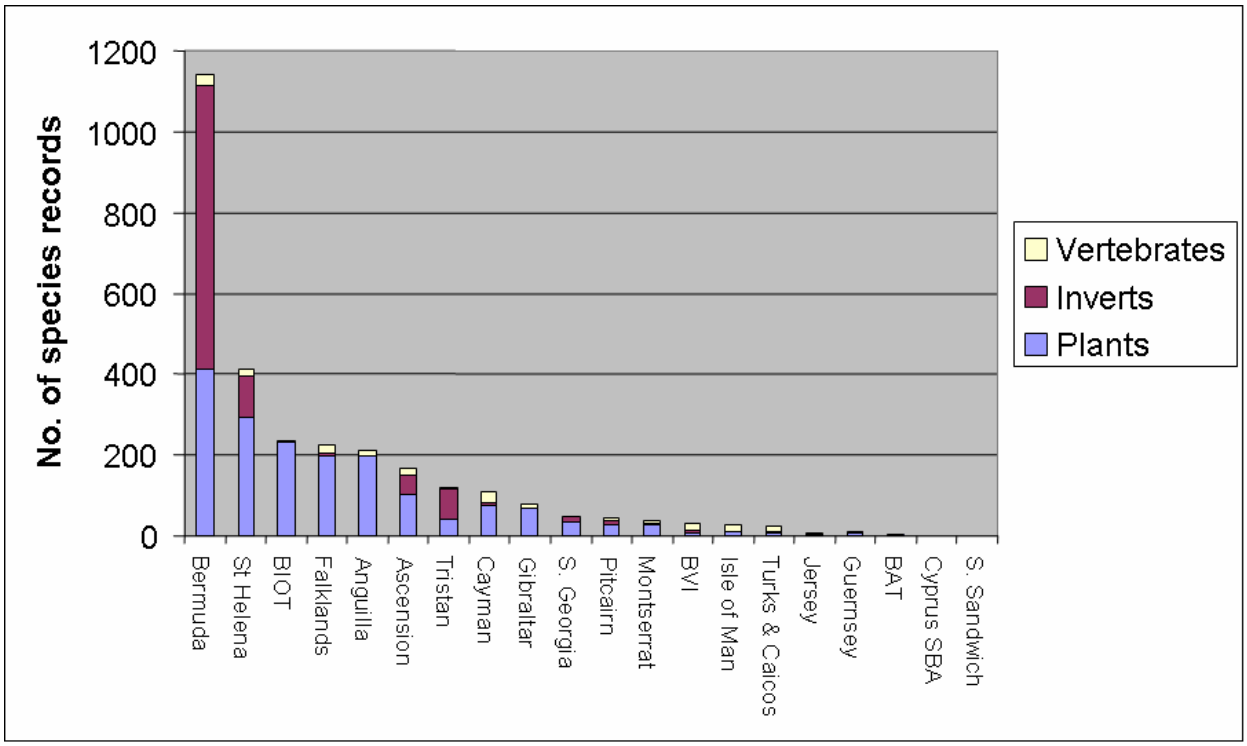

Figure 1. The number of non-native species recorded in each Territory ranked in order of the number of non-native species (BIOT – British Indian Ocean Territory; BVI – British Virgin Islands; TCI – Turks & Caicos Islands; BAT – British Antarctic Territory; SSI – South Sandwich Islands). Source: Varnham (2006)

Territories with fewer records of non-native species are predominantly those for which systematic collections of records were unavailable or inaccessible. For most of these territories we received fairly small numbers of records, usually from one or a few local experts. These records, although small in number, often contained very full and up-to-date information about non-native species, especially the ones known to be causing ecological problems in the territory. This is in contrast to the records taken from systematic lists which, in some cases, had little or no supporting information beyond a scientific name and, perhaps, some sketchy information on distribution. However, for most of the territories on the right hand side of the Figure 1, the numbers of non-native species are probably seriously under-recorded. The exceptions are the British Antarctic Territory and the South Sandwich Islands, for which the figures are based on recent work by the British Antarctic Survey and are believed to be an accurate (but non-natives on South Georgia are probably under-recorded; administratively, South Georgia and the South Sandwich Islands are one UKOT).

This database is just one of a range of resources on invasive species now available. Other database projects, such as the CABI Invasive Species in the Caribbean database (Kairo *et al*., 2003) and the Global Invasive Species Database (http://www.issg.org/database) are also extremely useful sources of complementary information. The unique feature of this project, however, is that the majority of the entries in this database have come directly from people living and working in the UKOTs and CDs and we hope these people will be the ones to benefit from it. Although there are clearly some gaps in information, the database is potentially a valuable tool for sharing information and expertise within the UKOT and CD community. It contains data from a wide range of unpublished written sources, many of which are difficult to access, and thus allows this information to be shared more widely for the first time. The database could also have an important role to play in helping to prioritise which invasive species are posing the biggest threats to biodiversity and hence which should be tackled first. It could also be an important research tool for studying the distribution and effects of invasive species.

So what are the next steps in using this database to inform work on non-native species in the UKOTs and CDs? As with all databases, it will quickly become obsolete if it is not updated regularly. Accordingly, JNCC are committed to continue to keep this database up to date and to publish periodic updates on the internet. We recognise that this is a two way process, requiring us having to search actively for new information (and we are aware of some datasets that we have missed) but we also hope that colleagues in the UKOTs/CDs may inform us of any new information which becomes available. We are also conscious that the accessibility of the database on the internet could be improved, for example, through better search functions and links to other relevant sources of information and we hope to address these. However, the true value of the database will be realised only if it used to make a practical and tangible contribution to tackling the problem of invasive species in the UKOTs and CDs.

Acknowledgements

We repeat our gratitude to all those who gave generously of their time and information to contribute to this project.

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Non-native species – Current Great Britain Perspectives

Niall Moore, Non-native species Secretariat, CSL

Moore, N. 2007. Non-native species – Current Great Britain Perspectives. pp 204-205 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Due to the growing global problem with invasive non-native species, Defra and the devolved administrations in Scotland and Wales instigated (in 2001) a comprehensive review of policy in this area. The first of the eight key recommendations of this review (see Cheesman & Clubbe, this volume) was the need for more effective co-ordination across Government. Ministers agreed to the establishment of a cross-departmental co-ordinating mechanism for non-native species and this Programme Board was set up in September 2005.

The Programme Board is intended to deliver strategic consideration of the threat of invasive non-native species across Great Britain, and to co-ordinate non-native species policy across Government. It comprises a small and highly focussed Board of key individuals, exercising power and responsibility in their own areas and acting as representatives of wider interests. This approach demonstrates a step-change in the development of ideas and delivery of outcomes on non-natives species issues across Great Britain.

The Board's remit includes:

- Developing a vision for addressing non-native species issues
- Coordinating research
- Ensuring the exchange of experience, information and specialist expertise
- Increasing public awareness of the key issues
- Encouraging constructive engagement with industry and other key stakeholders.

The Programme Board is supported in its work by an independent Secretariat, based at Central Science Laboratory (CSL). This secretariat consists of two full-time staff. Current work includes:

- Developing a GB Strategy on non-native species
- Setting up a risk assessment panel
- Setting up a monitoring system for non-native species
- Carrying out rapid reaction (e.g. to recent arrival of the water weed *Ludwigia*)
- Setting up a website.

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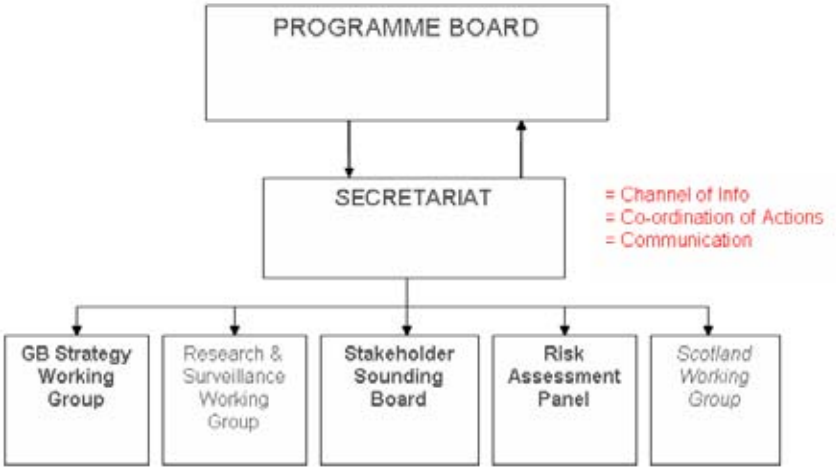

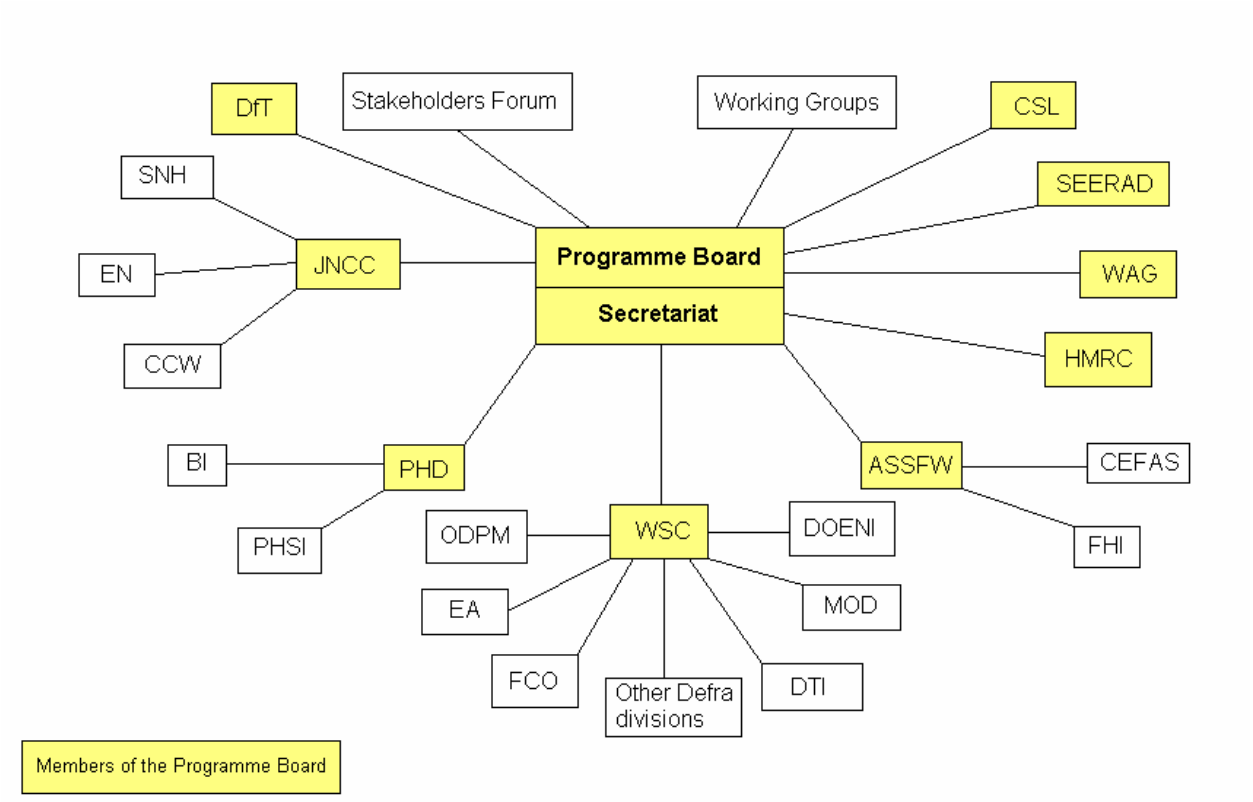
DfT
Stakeholders Forum
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Programme Board
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Secretariat
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HMRC
BI
PHD
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PHSI
ODPM
WSC
DOENI
FHI
EA
MOD
FCO
Other Defra divisions
DTI
Members of the Programme Board

Initiative on Invasive Alien Species in the French Overseas Territories

Jean-Philippe Palasi, IUCN Office for Europe and Yohann Soubeyran, IUCN French Committee

Palasi, J-P. & Soubeyran, Y., N. 2007. Initiative on Invasive Alien Species in the French Overseas Territories. pp 206-207 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Initiative on invasive alien species in the French overseas territories

Comité français UICN Union mondiale pour la nature

"Conserving the diversity of nature"

A major threat on biodiversity worldwide

According to IUCN Red List of threatened species, exotic invasive species are the third global threat on biodiversity in the world. They played a role in half of every extinctions in the past 400 years.

Globalisation of human activities means the phenomenon is increasing very fast. Habitat destruction and global warming are also key factors contributing to the expansion of invasive species.

Invasive species can have dangerous consequences for natural ecosystems and human societies. They impact tourism by reducing landscapes attractivity, damage agriculture, and can even be a threat for human health in the case of viruses, bacteria and some insects.

French overseas territories on the front line

French overseas regions and territories host a biodiversity of worldwide importance, with 3450 endemic plants and 380 endemic vertebrates.

They are however very sensitive to introductions of species, in particular in islands, where fauna and the flora often evolved without the pressure of predators or competitors.

invasive Alien species ?

Aliens species whose introduction, installation and propagation threaten indigenous ecosystems, habitats or species with environmental and/or economic and/or sanitary negative consequences.

Introduced voluntarily or accidentally, they occur in both terrestrial and marine fields, with a particular impact on insular terrestrial ecosystems.

With the arrival of humans, many plant and animal species were introduced (for example 2200 plants in Réunion island, 1350 in New Caledonia, 1700 in French Polynesia), and more are still being introduced currently. Some of them are very invasive and aggressive, and become a major cause of biodiversity loss.

A large number of international cases of combating invasive species show that success is possible. French overseas territories must be mobilized to defend their natural wonders, which are a key element of their cultural identities and economic assets.

Building an action network for all French overseas territories

Many actors in overseas territories mobilize against invasive species. In spite of their geographical and ecological differences, French overseas territories are often confronted with common difficulties: weak awarness of the public, poorly accessible scientific data, lack of tools for coordination, unsuited legal instruments, etc.

This program aims to support exchange of information and coordination between all actors involved (NGOs, researchers, national and local authorities). It will be carried out in collaboration with IUCN's Invasive Species Specialists Groupe (ISSG), and will also be a contribution to a key priority of the French Strategy for the Biodiversity adopted in 2004.

Carry out a review of information

- Scientific : identification of the most dangerous species (biology, distribution, dispersion, impacts, etc)
- Technical : inventory of management and research programs, and good practices
- Legal : evaluation of the existing legal tools and their application

Improve the diffusion of information

- Organization of a network of exchange between overseas territories
- Publication of a synthesis including a guide of good practices
- Diffusion of data through an online database

Propose recommendations

- To improve awarness of authorities, NGOs, population, the private sector
- To improve the legal framework for prevention and control of invasions
- To increase the means and funding dedicated to fight invasive species

The initiative is open to all actors concerned. Its purpose is to reinforce at the same time prevention (awarness, tools) and actions on the ground (coordination, access to data, priorities identification).

Comité français
UICN
Union mondiale pour la nature

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This initiative belongs to a program on French overseas territories developped by IUCN French Committee. Priorities are : improvement of scientific knowledge, analyze and influence on public policies, local capacity building. For more information contact Jean-Philippe Palasi, Program officer for Overseas Territories : jp.palasi@uicn.fr

With support from :

Region Reunion

la Fondation

November 2005. Credits : O. Gargominy, JM. Meyer, J. Le Breton, JP. Palasi, Megaptera.

Turks and Caicos Islands Invasive Pine Scale

Martin Hamilton, Royal Botanic Gardens, Kew

Hamilton, M. 2007. Turks and Caicos Islands Invasive Pine Scale. pp 208-213 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

An invasive non-native scale insect pest was discovered on Caribbean Pine *Pinus caribaea* var. *bahamensis* in the Turks and Caicos Islands (TCI) in 2005. Since then, it has spread rapidly and caused high levels of mortality to the pine, leading to degradation of habitats. Experience with this devastating pest in TCI emphasises the need for rapid response mechanisms when dealing with invasive species.

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The Caicos Pine

The Caribbean Pine *Pinus caribaea* var. *bahamensis* is the national tree of the Turks and Caicos Islands (TCI). It is endemic to the Bahamian Archipelago, but has a disjunct distribution within that area. In the Bahamas, it is restricted to the northern islands of Grand Bahama, Abaco, Andros and New Providence. South of the Bahamas but in the same geographical system, in TCI the Caicos Pine occurs on Pine Cay, Middle Caicos and North Caicos, where it is the key species of the pineyard ecosystem.

Developing cones, Middle Caicos

Infection

In January 2005, during fieldwork for the OTEP-supported project run by the Turks & Caicos National Trust (TCNT) and the UK Overseas Territories Conservation Forum, non-native scale insects were first observed and collected on Middle Caicos by personnel from TCNT and the Royal Botanic Gardens (RBG) Kew. In April 2006, scale insects

Pine tortoise scale Toumeyella parvicornis

Range of damage on Pine Cay

April 2006: Recording & Monitoring

Dead trees on Pine Cay

were recorded and collected on North Caicos, Middle Caicos and Pine Cay.

Initial diagnosis suggested that the rapidly spreading pest was the pine tortoise scale *Toumeyella parvicornis*, a well known species in North America on Pinaceae. If this is the species now occurring in TCI, the infestation represents both a new host record and the first record for the region. [Since the presentation, this has been confirmed.]

The impact of the scale insect is severe, but varies somewhat between sites. Some areas contain no live trees or seedlings; others still support some live pines amongst dead and moribund trees. Infestation levels are high on seedlings in many areas. In combination with massively reduced cone production by mature trees, this threatens on-going recruitment into the pine population, with the prospect that the tree could be lost altogether from

Developing cones on Pine Cay

"Healthy" trees on Pine Cay

Infested pine on Pine Cay

Infested/dying trees on North Caicos

Martin Hamilton and B. Naqqi Manco observing seedlings, Middle Caicos

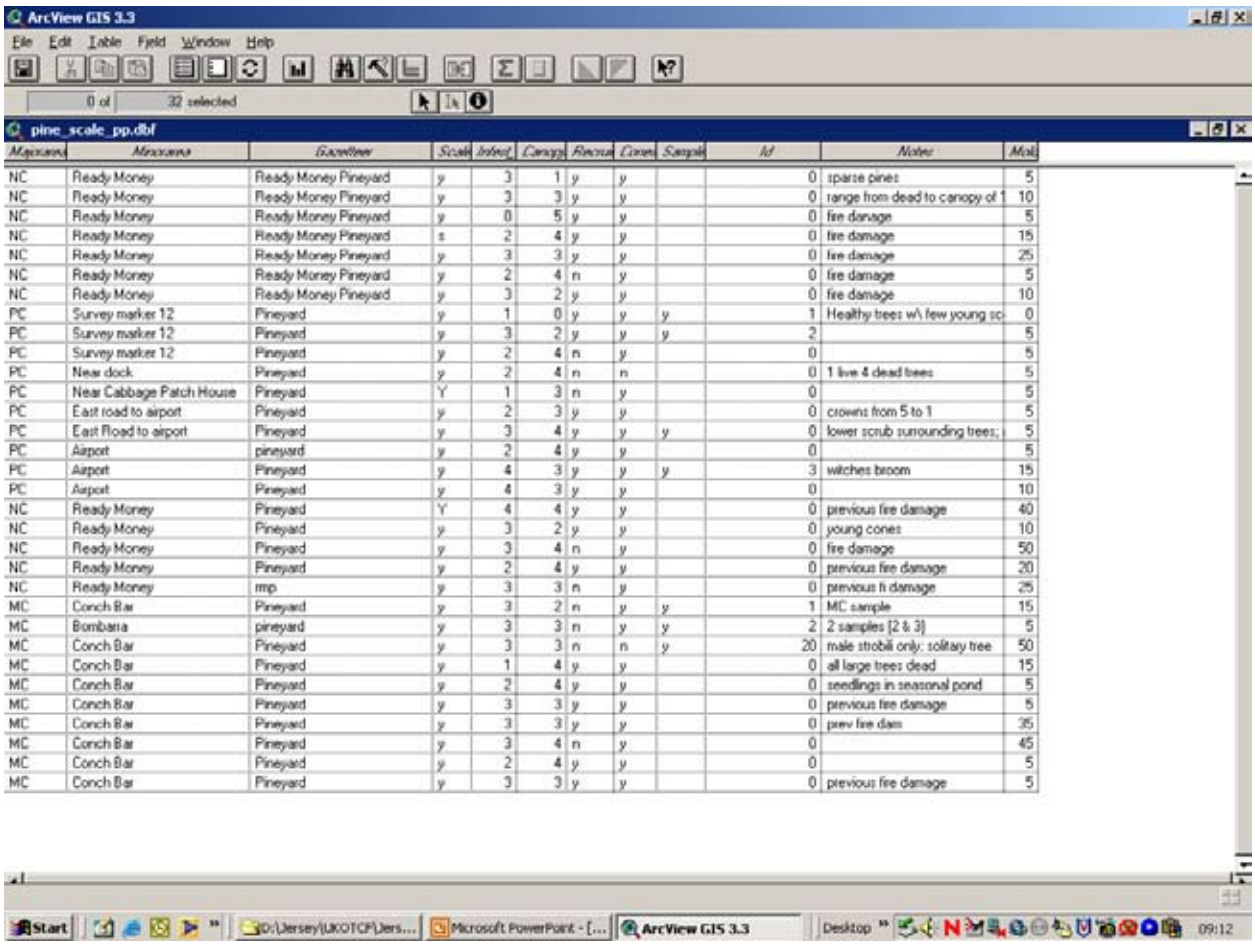
Scale on seedling, North Caicos

Infested seedling, Middle Caicos

Monitoring tape applied to pine branches, North Caicos

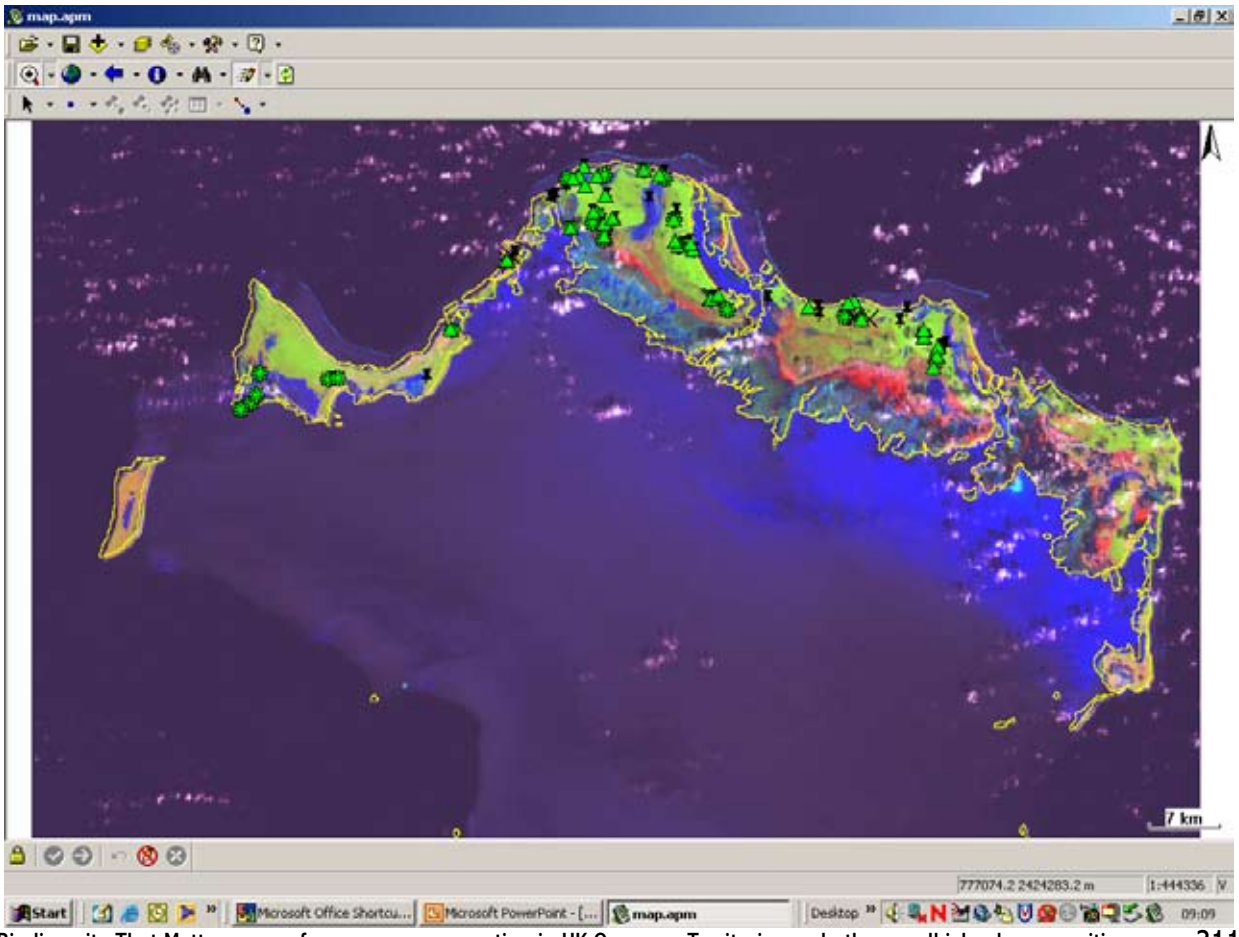
Dead trees, Middle Caicos

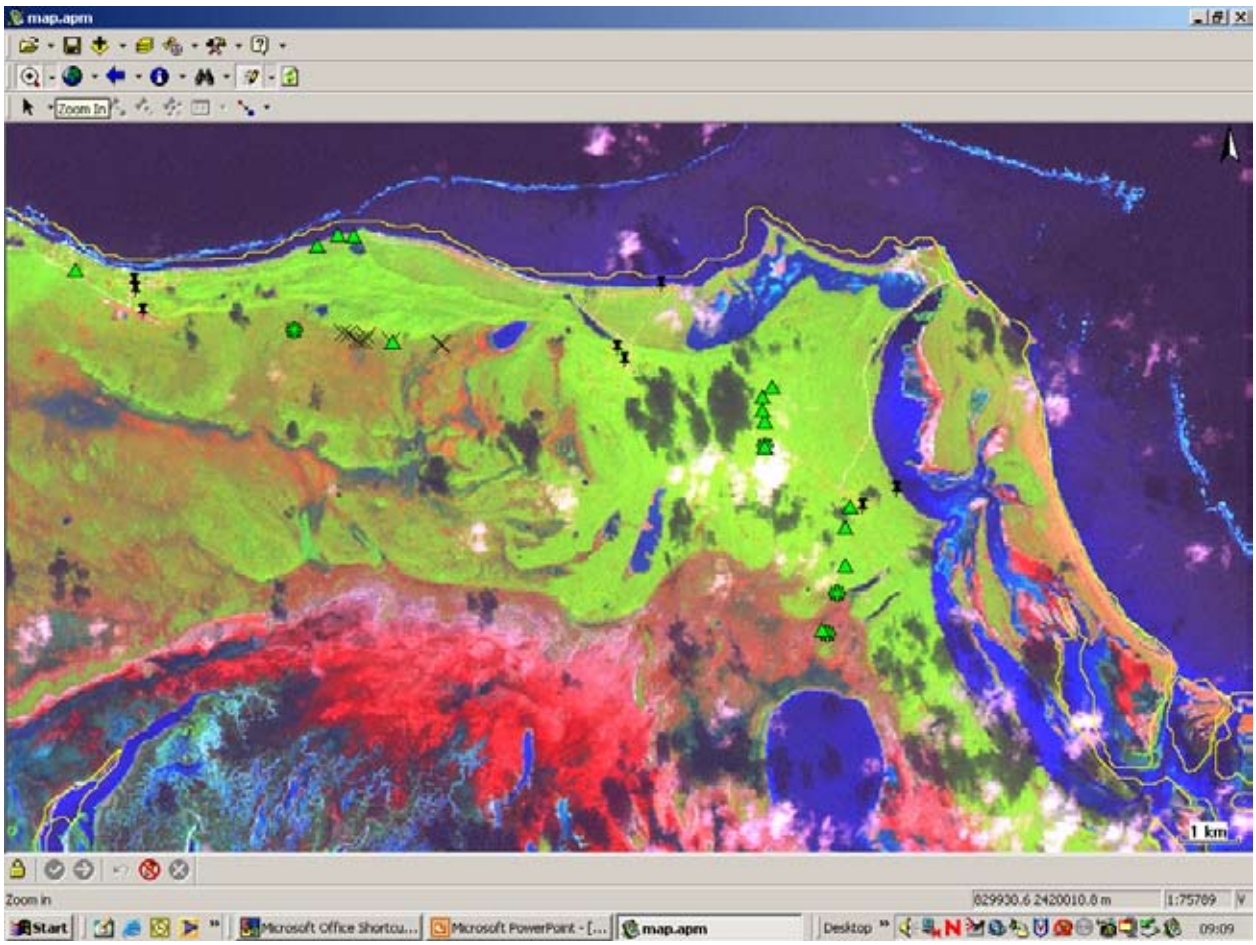
Collecting sampling tapes, Middle Caicos



Mapname	Mapname	Gazetteer	Scale	Intens	Canopy	Recruit	Crown	Sample	Id	Notes	Mois
NC	Ready Money	Ready Money Pineyard	y	3	1	y	y		0	sparse pines	5
NC	Ready Money	Ready Money Pineyard	y	3	3	y	y		0	range from dead to canopy of 1	10
NC	Ready Money	Ready Money Pineyard	y	0	5	y	y		0	fire damage	5
NC	Ready Money	Ready Money Pineyard	s	2	4	y	y		0	fire damage	15
NC	Ready Money	Ready Money Pineyard	y	3	3	y	y		0	fire damage	25
NC	Ready Money	Ready Money Pineyard	y	2	4	n	y		0	fire damage	5
NC	Ready Money	Ready Money Pineyard	y	3	2	y	y		0	fire damage	10
PC	Survey marker 12	Pineyard	y	1	0	y	y	y	1	Healthy trees w\ few young sc	0
PC	Survey marker 12	Pineyard	y	3	2	y	y	y	2		5
PC	Survey marker 12	Pineyard	y	2	4	n	y		0		5
PC	Near dock	Pineyard	y	2	4	n	n		0	1 live 4 dead trees	5
PC	Near Cabbage Patch House	Pineyard	Y	1	3	n	y		0		5
PC	East road to airport	Pineyard	y	2	3	y	y		0	crowns from 5 to 1	5
PC	East Road to airport	Pineyard	y	3	4	y	y	y	0	lower scrub surrounding trees;	5
PC	Airport	pineyard	y	2	4	y	y		0		5
PC	Airport	Pineyard	y	4	3	y	y	y	3	witches broom	15
PC	Airport	Pineyard	y	4	3	y	y		0		10
NC	Ready Money	Pineyard	Y	4	4	y	y		0	previous fire damage	40
NC	Ready Money	Pineyard	y	3	2	y	y		0	young cones	10
NC	Ready Money	Pineyard	y	3	4	n	y		0	fire damage	50
NC	Ready Money	Pineyard	y	2	4	y	y		0	previous fire damage	20
NC	Ready Money	mp	y	3	3	n	y		0	previous fi damage	25
MC	Conch Bar	Pineyard	y	3	2	n	y	y	1	MC sample	15
MC	Bombaria	pineyard	y	3	3	n	y	y	2	2 samples [2 & 3]	5
MC	Conch Bar	Pineyard	y	3	3	n	n	y	20	male strobili only; solitary tree	50
MC	Conch Bar	Pineyard	y	1	4	y	y		0	all large trees dead	15
MC	Conch Bar	Pineyard	y	2	4	y	y		0	seedlings in seasonal pond	5
MC	Conch Bar	Pineyard	y	3	3	y	y		0	previous fire damage	5
MC	Conch Bar	Pineyard	y	3	3	y	y		0	prev fire dam	35
MC	Conch Bar	Pineyard	y	3	4	n	y		0		45
MC	Conch Bar	Pineyard	y	2	4	y	y		0		5
MC	Conch Bar	Pineyard	y	3	3	y	y		0	previous fire damage	5

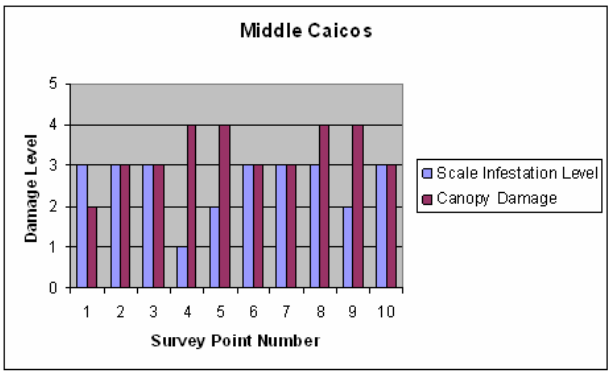
Above is a screen-grab from ArcView showing a table of data collected during April 2006 monitoring of the pine scale. Below (and part of Middle Caicos at larger scale on the next page) are screen-grabs from ArcPad showing the

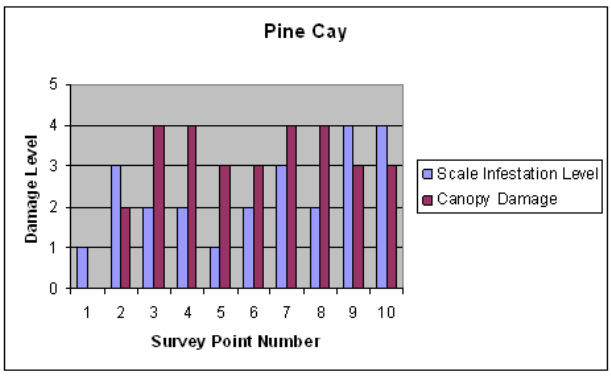


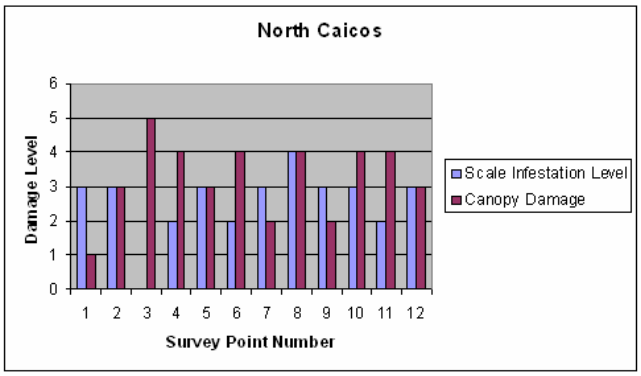


places visited during the April 2006 trip to collect data. Green symbols are either herbarium specimens or vegetation assessment points, black pushpins are places, black "x" scale recording points.

The diagrams below show average infestation levels and canopy damage for the pine trees at the sampling points visited on the three islands







Infestation levels:
0 = no visible scale
5 = totally infested

Canopy damage:
0 = no visible damage
5 = tree mortality

Fire ignited by lightening in the pineyard, North Caicos

many areas. The loss of trees is already resulting in visible habitat degradation in TCI pineyards. As well as further impacts of the pest itself, lightening-induced fires may be more frequent in areas with greater concentrations of dead trees, leading to further losses.

Recommendations

RBG Kew and TCNT have been working together to develop proposals for measures to tackle the threat posed by this invasive alien insect pest. Key recommendations include:

- Establishment of a nursery
- Establishment of a seedling rescue programme
- Establishment of a seed collecting programme
- Awareness raising throughout TCI (see RBG Kew's poster on its UK Overseas Territories Programme in the section on other topics)
- Control of importation of infected plant material
- Enhanced monitoring of the scale insect and its impacts
- Alerting NGOs and governmental agencies in the region
- Conducting targeted research on the pest
- Evaluation of systemic insecticides for control
- Evaluation of managed burning (for pest control and removal of surplus dead wood)
- Acquisition of funding for on-going work, including:
  - Provision of GIS system for monitoring and mapping
  - Investigation of biocontrol options
  - Education and awareness raising
  - Investigation of prospects for pine reintroduction.

The speed with which this pest has spread, and the damage that it has already done to the native pine and its associated ecosystem in TCI, emphasises the need for rapid response mechanisms in invasive species management.

Section of North Caicos pine yard

The Repercussions of Hurricane Ivan for Invasive Species in Grand Cayman, Cayman Islands

Dr Mat Cottam, Cayman Islands Department of the Environment

Cottam. M. 2007. The Repercussions of Hurricane Ivan for Invasive Species in Grand Cayman, Cayman Islands. pp 214-217 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

In 2004, the Cayman Islands contributed to the JNCC report on Non-native species in UK Overseas Territories (No.372), identifying some 110 locally naturalized / invasive species of flora and fauna. With respect to impact on the natural environment, feral cats, dogs, rats and Green iguanas *Iguana iguana* are probably the most significant faunal invasives. Whistling Pine *Casuarina equisetifolia*, Scaevola *Scaevola seriacea*, Wild Tamarind *Leucaena leucocephala* and Logwood *Haematoxylum campechianum* are the most significant floral invasives. The long-term on-island persistence of these species has contributed to public acceptance: a shifting-baseline which complicates control efforts and the effectiveness of awareness raising.

Hurricane Ivan impacted both native and non-native species. High winds and heavy seas destroyed significant areas of coastal forest, especially along the southern shore of the island. Additionally, large areas of damaged vegetation were bulldozed, prior to potential regeneration. This combination of natural and mechanical clearance contributed to large areas of disturbed ground being opened-up for colonization by invasive species.

Biological surveys indicate that Grand Cayman's bat population was reduced by some 84%, with many bird species suffering similar or even greater losses. In the wake of the storm, the evacuation of over 10,000 inhabitants contributed to the abandonment of many domestic pets.

Damage to mangroves was exacerbated in some areas by the interruption of natural drainage channels by road developments. The resultant standing floodwater drowned large areas of trees. An almost total loss of the island's greenery contributed to an increased public interest in the value of native trees, especially mangroves. However, limited capacity contributed to emergency priorities overriding long-term environmental management, compromising opportunities to capitalize on the storm's temporary impact on invasive flora. Two years later, invasive flora are significantly more widespread than prior to the storm.

Towards initiating practical control of invasive flora, the Department of Environment is working with the Queen Elizabeth II Botanic Park and Darwin Initiative partners to establish a native tree nursery: encouraging the public to plant with native species, and generating stock for restoration of native landscapes. The implementation of improved conservation programs is also a key focus, including the Royal Botanic Gardens Kew Millennium Seedbank Project.

Invasive species present an ever-evolving issue for the Cayman Islands. In 2006, Pink Hibiscus Mealy Bug established for the first time in Grand Cayman.

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Scaevola
Scaevola sericea

Before Hurricane Ivan

The 2006 JNCC report by Karen Varnham indicates some major invasive species:

Non-native Scaevola *Scaevola sericea*, used for green coastal landscaping

Whistling Pine *Casuarina equisetifolia*, shade tree and "whistling needles"

Logwood *Haematoxylum campechianum*, used in the dye trade

Wild Tamarind *Leucaena leucocephala*, possibly an accidental introduction.

The OTEP-funded Cayman plants Red List was completed in 2006, showing:
Critically Endangered – 83 taxa
Endangered – 64 taxa
Vulnerable – 45 taxa
Near-Threatened – 6 taxa
Least Concern – 131 taxa
Date-Deficient – 86 taxa.

Whistling Pine Casuarina equisetifolia

Public perceptions to non-native species before Ivan included shifting baselines; invasive species insinuated themselves into the local environment – and also into local culture.

Hurricane Ivan

Hurricane Ivan struck Grand Cayman on 12th September 2004. It exposed Grand Cayman to hurricane category 4-5 force winds for many hours. High seas and giant waves impacted the south coast, and torrential rain contributed to the majority of the island being underwater during this period.

Darwin Initiative

At the time that Ivan struck, a Darwin Initiative application was in preparation. This was rewritten to take account of the impact of the hurricane and need for new environmental assessment. It was

successful in acquiring funding for updated habitat mapping and production of a National Biodiversity Action Plan (NBAP) for the Cayman Islands.

After Ivan

There was extensive loss of, and damage to, surviving vegetation: loss of leaves, branches, thrashing effect, salt-water inundation, and standing water.

There were impacts on invasive species. Some were positive, such as:

- Toppling of Casuarinas
- Increased public interest in the value of mangrove for storm protection.

Many others were negative:

- "Brown island" – leads to desperation for any greenery
- Large areas of native vegetation lost - damaged vegetation tidied up (by bulldozer)
- Invasives quickly colonised open / "tidied" areas
- No capacity for immediate response… leaving invasive species free to re-establish and more…

The current situation

Black mangrove has been devastated, destroying important nest-sites for parrots. A nest-box scheme has had some limited success.

The Department of the Environment has recently purchased weed wrenches and will enjoy some field-testing on Casuarinas.

Removal will be futile if replanting with native species is not undertaken immediately, due to top-up effects from neighbouring properties.

There is work on improving and developing new conservation programmes at QEII Botanic Park, in partnership with Royal Botanic Gardens Kew e.g. Native Tree Nursery and Millennium Seed Bank.

These provide practical alternatives to non-native landscaping, and stock for replacement of invasive species.

Intervention strategies in pest control

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Pest control requires both the tools and the knowledge of where and when to use them, in particular for tools that require an 'on' and 'off' application. These decisions have to be made in the context of the economics of the intervention, and funds available. This paper describes two eradication case studies to illustrate start-and-stop rules using some elements of risk analysis.

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Introduction

Pest control requires both the tools to manage the pest (better mouse traps) and the knowledge on where and when to use them. For most pests we have an array of tools from simple traps and rifles, albeit now used with smart technologies such as GPS and radio-telemetry (Campbell *et al*. 2005), through to designer baits and toxins (e.g. Morgan 2004), with even more high technology solutions being researched (e.g. species-specific toxins and genetically-engineered biocontrol agents.

However, for all tools that require an 'on' and 'off' application, the tricky decisions remain on where and when to intervene against the pest – unless of course one has unlimited funds to intervene everywhere all the time! This is essentially a bioeconomic problem if optimal solutions are to be found (Parkes *et al.* 2006).

Managers of pests have three general strategies to consider for pests: doing nothing, sustained control, or eradication. Each of course requires a different set of decisions on intervention. A decision not to intervene against a pest may be made when no tools (or funds) are available to be effective, a sensible decision for say most established marine invasive pests. Optimal intervention under the sustained control strategy requires knowledge on how the pest-resource system interacts so that either acute or chronic impacts can be managed (Parkes 1993), or biological thresholds identified and target densities set (Choquenot & Parkes 2001).

Eradication is strategically simpler than sustained control as it is not necessary to understand these complex interactions. Intervention is based on some analysis of feasibility (e.g. Parkes 2006) and a decision to stop is based on achievement of zero pests.

In this paper, I will use two eradication case studies to illustrate start and stop rules using some elements of risk analysis.

Eradication of red deer from Northland, New Zealand

The problem

The Northland region of North Island in New Zealand is free of wild deer *Cervus elaphus* but has 58 farms where a total of 12 520 deer were held in the late 1990s (Fraser *et al.* 2003). Managers of the conservation estate consider these exotic deer a pest, and farmers are concerned that wild deer present risks to the bovine TB-free status of the region.

Between 1993 and 1999, deer escaped from these farms on 27 occasions with 26% of the farms reporting at least one event. A mean of 13 deer were involved per event (range 1 to 270 animals). In 85% of events the animals were recaptured and in all the rest the escapees were shot by government employed hunters at a cost of c. £30 000 per year.

A question

Should managers allocate more funds to being proactive or more to being reactive? Proactive management would include enforcing fencing standards, and public relations to encourage good practice and discourage bad practice such as illegal liberations. Reactive management would include surveillance and prompt response to events.

The answer depends on the causes of the escapes and the cost of dealing with them. In this case, the costs of dealing with them are affordable and the problem tractable, so the issue becomes one of cause.

Results

36% of events were caused by human error (e.g. gates left open by mistake), 30% by "acts of God" (e.g. storm damage to fences), and 33% were caused by manageable flaws (e.g. inadequate fences).

Thus, a rough partition of the funds to match the risk would be to spend 67% on being reactive and only 33% on being proactive.

Eradication of feral pigs from Santa Cruz Island, California

The problem

The Nature Conservancy (TNC) has spent a large sum of money (many millions of dollars) attempting to eradicate feral pigs *Sus scrofa* from Santa Cruz Island (25 000 ha) in the Channel Islands of California (Ramsey *et al.* in prep). The hunting contractors (Prohunt Ltd) have removed several thousand pigs since they began in late 2005 but have not killed any, despite large efforts, since mid-2006. The eradication has been politically sensitive and TNC has been forced to spend large sums defending their actions in the courts.

The cost of falsely declaring eradication and paying off the contractor is not large in terms of reacting technically to any future sighting of a pig, BUT the cost in terms of litigation might be fatal to the cause.

Questions

How certain can TNC be that the string of zero detections equal eradication, or how much more monitoring with zero detection would achieve a desired level of certainty?

Results

Ramsey *et al.* (in prep.) have used the hunting data from helicopter hunting, ground hunters with dogs and radio-telemetered Judas pigs to calculate the detection probabilities for each hunting method, i.e., the probability that if a wild pig was present it would be detected on x occasions by the method. Using Bayes theorem, the probabilities that a pig remains despite the strings of zero detections can be calculated and the risks of false conclusions assessed.

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Poster: Invasive species management on islands; raising awareness, generating support, building capacity

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Invasive species management on islands; raising awareness, generating support, building capacity.

Pacific Invasives Initiative – a regional programme of the Cooperative Initiative on Invasive Alien Species on Islands

The goal of the Pacific Invasives Initiative (PII) is to conserve island biodiversity and enhance the sustainability of livelihoods of men, women and youth in the Pacific. The PII is primarily focused on supporting Demonstration Projects to raise awareness of invasive species impacts and generate support and develop capacity for invasive species management.

The PII is a partnership which acts as a catalyst, coordinator and facilitator for invasive species management; provides and facilitates technical and scientific expertise; promotes and facilitates cooperation, networking and information sharing.

A) Discussing locations for toxic baiting with the work team on Fakaofo Atoll, Tokelau.
B) Training for field crew in distributing toxic ant bait in the field on Fakaofo Atoll.
C) Tokelauan working alongside Victoria University team member assembling cages for hermit crab research.
D) The baiting team, including two quarantine officers, on Nukunonu Atoll, Tokelau.
(Photos: Kirsti Abbott)

Erecting a nestbox trap for jungle mynas (*Acridotheres fuscus*) on Tokelau.
(Photo: Bill Nagle)

Pacific rat (*Rattus exulans*) bait station training, Viwa Island, Fiji.
(Photo: Karen Johns)

Projects supported by the Pacific Invasives Initiative –

- Management of the invasive weed *Mimosa pigra*, **Papua New Guinea**.
- Multi-species mammal control on Mt Panie, **New Caledonia**.
- Singapore ant (*Monomorium destructor*) eradication in Hatohobei State, **Palau**.
- Challenging the yellow crazy ant (*Anoplolepis gracilipes*) on **Tokelau**
- Restoration of the Aleipata Island Group, **Samoa**.
- Viwa Island restoration project, **Fiji**.
- Assessment of potential threats to biodiversity from invasive mosquitoes in **Tonga.**
- Restoration of Vahanga Atoll, Tuamotu Archipelago, **French Polynesia**.
- Protection of Tanga'eo, the endemic Mangaia (**Cook Islands**) kingfisher from common myna (*Acridotheres tristis*).
- Phoenix Islands conservation survey, **Kiribati**.
- Eradication of Pacific rats (*Rattus exulans*) on Vatu'i'ra Island, **Fiji**.
- Eradicating rats (*Rattus exulans, R. rattus*) from Ahnd Atoll, **FSM**.
- Feasibility of rat (*Rattus exulans, R. rattus*) and other invasive species eradication from Kayangel Atoll, **Palau**.
- Protection of **Tokelau** Fakaofo from myna (*Acridotheres* spp.) bird invasion.
- Prospects for biological control of *Merremia peltata*.
- Pacific Ant Prevention Programme.

Cooperative Islands Initiative Pacific

For more information, visit:
Pacific Invasives Initiative
www.issg.org/cii/PII

(Background photo:AK Kepler)

Working for Water (South Africa) – the Biggest Invasive Alien Species Management Programme in the Developing World

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This paper describes the South African Working for Water (WfW) invasive alien plant management programme. The background to, and history of, WfW are discussed, as are some of the factors that have enabled the programme to become an example of how IAS considerations can be mainstreamed in developing countries. The applicability of the WfW model to islands in the Western Indian Ocean is examined in regard to a possible WfW style project in Rodrigues.

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Introduction and history of the Working for Water programme

Invasive alien plants have become established on over 10 million hectares of land in South Africa. Modeling studies have demonstrated how some lightly infested catchments can become densely infested over a period between 10 and 15 years (Le Maitre *et al.* 1996). This has a serious economic cost, which will rise if timely management is not carried out.

South Africa is a dry country and water scarcity is likely to limit economic growth (Huntley *et al.* 1989). Reviews published in the 1980s and 1990s suggested that invasion of catchments by alien trees in South Africa would seriously reduce water supplies (e.g. Versfeld and van Wilgen 1986). This issue had been long recognized by ecologists but this knowledge had not yet filtered into the consciousness of decision-makers (van Wilgen *et al.* 1996).

In 1995 the argument was put forward by Guy Preston, then a researcher at the University of Cape Town (now National Leader of the WfW programme), that the new post-apartheid government of South Africa should not build dams and water-transfer schemes until catchment management is optimised in ways that are efficient, equitable and sustainable. The then Minister of Water Affairs and Forestry, Kader Asmal (a former university professor), was convinced by the scientific arguments that clearing of invasive alien plants was central to efficient catchment management. The Fynbos Forum, a collection of academics and practitioners in the Western Cape, was also very instrumental in bringing the issue of invasive species to the attention of key decision makers.

Job creation and the pursuit of social equity were central to the manifesto of the new regime under Nelson Mandela, which came to power in 1994. The Working for Water Programme (WfW) was launched in 1995 as a means of achieving social and economic benefit through an environmental programme. The justification for the programme was also very linked to the protection of biological diversity, the need to stem exacerbating problems associated with fire (as well as flooding, erosion, water quality, etc) and the need to maintain land for productive use.

WfW stands out as a classic example of mainstream-

ing of invasive species management programmes (Cowling *et al.* 2002). These mainstream concerns are encapsulated in the WfW Mission Statement which is as follows: 'The Working for Water programme will sustainably control invading alien species, to optimise the potential use of natural resources, through the process of economic empowerment and transformation. In doing this, the programme will leave a legacy of social equity and legislative, institutional and technical capacity.

WfW focuses on four main areas to support strategies for dealing with the problem of invasive alien plants:

1. Job creation
2. Biological control
3. Public education and communication
4. Creating an enabling legislative environment.

The programme has now grown to the point that its budget for 2003/4 is R442 million (c.$US68 million at November 2003 exchange rates). It directly employs over 20,000 people in over 300 separate projects throughout South Africa. The programme targets some of the most marginalized groups in South African society including women, single parent heads of households, the youth, the disabled, those leaving prison, and military veterans.

The achievements of the WfW programme have been recognized worldwide. This recognition is reflected in its association with 38 national and international awards.

Reasons for the success of Working for Water

Good science

From the outset the programme was based on good science. It was this science that persuaded decision-makers to act in the first place. However, the WfW programme has not waited for absolute scientific proof before acting. In many cases the science that can aid management has been catalysed by the practical work in the field. Typical of the research catalysed by WfW have been studies on the impacts of invasive alien plants on hydrological regimes (Le Maitre *et al.* 2000), the modeling of management methods at the landscape scale (van Wilgen et al. 2000) and research and development in biological control techniques (Zimmermann & Klein 2000). An indication of WfW's role in catalysing research in many disciplines was the first WfW research symposium held in 2003 which presented outcomes of research in hydrology, biological control, ecology, social development, occupational health and safety, and resource and development economics.

Good marketing

The WfW programme has always marketed itself well. WfW has developed a very distinctive logo that evokes inclusiveness, and progress, areas of great importance for post-apartheid South Africa. The distinctive yellow WfW tee shirts have been worn by countless celebrities at countless photo opportunities. The fact that the programme's patron is Nelson Mandela is indicative of well-placed support. In addition WfW supports, and is supported by, high profile events and campaigns such as Arbour Week, which focuses on indigenous vegetation and 20/20 the Vision Programme that works with the Department of Education to develop water audits in schools.

Mainstreaming

This has been already highlighted and is a theme that runs throughout the programme. The work carried out under WfW on HIV/AIDS awareness,

the promotion of safe sex and of family planning are illustrative that the thinking of those involved in the programme goes a long way beyond invasive plants (McQueen *et al.* 2000).

Creating partnerships

The programme was established as a multi-departmental initiative led by the Departments of Water Affairs and Forestry, Environmental Affairs and Tourism and Land and Agriculture. Additional national partners now include all government departments but particularly Health and Welfare, Public Works, Provincial and Local Government, Correctional Services, Trade and Industry, Finance, Labour and Arts and Culture. In addition there are international partners with whom WfW has strong links including those dealing with IAS such as IUCN (the World Conservation Union), GISP (the Global Invasive Species Programme) and CABI (Centre for Applied Bioscience International) and regional blocks such as SADC (Southern African Development Community) and NEPAD (the New Partnership for Africa's Development). Partnerships with the private sector are also very strong.

High level political support

As mentioned Nelson Mandela is the patron of the WfW programme. The importance of the support given by Kader Asmal in establishing the programme cannot be underestimated. Indeed it seems likely that without his efforts WfW would not have got off the ground. The continuation of this political support, notably from the Ministers of Water Affairs and Forestry (Mr Ronnie Kasrils), Environmental Affairs and Tourism (Mr Valli Moosa) and Agriculture (Ms Thoko Didiza), has helped to ensure the programme's continued success.

Total integrity

The WfW programme is well known to operate a policy of zero tolerance of corruption. This means that every Rand spent must be accounted for. This can slow down some activities but it sends a clear message to stakeholders. This attitude is made very clear when reading WfW reports that discuss staff dismissals in a very frank manner.

The time was right

The ending of apartheid was probably a necessary but not sufficient condition for the development of WfW. It was this favourable timing together

with some of the other factors discussed above that turned a potential into reality.

Challenges for WfW

This paper discusses the reasons for the success of WfW. It would be naïve to assume that the journey has been, or still is, plain sailing. There are many problems. These include institutional arrangements, a lack of autonomy, unclear decision-making powers, unclear mandates, and adequate staffing. Indeed, it is has only been through the resolute dedication of many of its staff that WfW has been able to do what it has done. The need for dedication to the cause is very important to bear in mind as if this is not present even the best ideas can be destroyed by bureaucratic inertia, conservatism or downright antagonism.

Can we apply this approach regionally – the case for WFW Rodrigues

Rodrigues, the smaller of the two main islands that form the Republic of Mauritius has enjoyed considerable conservation success over the last few years. To maintain recent momentum it is imperative that existing efforts are scaled up (Maure-mootoo, this volume). A WfW-type project to restore the invaded watersheds of Rodrigues using native species is a possible means of achieving this increase in scale. Among the conditions prevailing in Rodrigues (some of which are analogous to those in South Africa) are the following:

Lack of water

Although almost all houses in Rodrigues are linked to a piped water supply many only receive piped water as infrequently as once per fortnight. Insufficient water is available for agricultural demand and development needs, notably in the tourist sector.

Most water is pumped from groundwater sources that are being used unsustainably.

Poverty and high unemployment

Rodrigues is the least developed district of the Republic of Mauritius with 33% of households, many of whom are female-lead, being classified as poor (<$1,250 household income per year) and 11% very poor (<$450 household income per year). Figures are not readily available, but is well known that unemployment in Rodrigues is considerably higher than the c.10% levels prevailing in the Republic of Mauritius as a whole (CSO 2002).

Introduced plants affecting water security

It is believed that introduced trees, many of which are known to be water-demanding are exacerbating water shortages in Rodrigues. Although data are lacking the morphological characteristics of most native trees (e.g. leathery leaves, slow growth rate, short stature and mainly shallow but widespreading roots) appear likely to make native trees relatively water-efficient. Many of the species that are known to be water-demanding are also highly invasive in Rodrigues so it seems likely the problem of water-demanding trees will increase if nothing is done.

Overfishing in lagoon

The Rodrigues lagoon is highly overfished. In 2001 c.2,000 Rodriguans were registered as fishers (AFRC 2001). Some of their income comes from fishing but in many cases the majority comes from a Government bad weather allowance, which serves as a form of social security. A certain number of days per year must be fished if fishers are to qualify for the allowance. Many of these are women who trample the lagoon to spear octopus. Octopus is highly overfished and trampling further damages the lagoon ecosystem as a whole. A labour-intensive forest restoration programme could help remove the need to overfish for octopus while at the same time having a positive effect on the environment.

Models for restoration can be scaled up

The restoration work undertaken in Rodrigues in the last few years has provided a model that can be extended to larger areas given sufficient funding, manpower and technical support.

A new political regime

Although it is not comparable with the ending of Apartheid in South Africa, the coming of regional autonomy in Rodrigues in 2002 was a very significant step for the island. The locally elected regional assembly is headed by a chief commissioner for the island. The chief commissioner, commissioners for key areas (analogous to ministers at the national level) and the assembly are responsible for day-to-day governance of the island. Clearly the new regime is anxious to make a decisive and positive impact on the day to day life of the island. An environment project that addresses social and economic concerns clearly has great potential in this respect.

Can we apply the model to other islands in the Indian Ocean region?

It is unlikely that most islands in the IOC region will have such similar circumstances to South Africa as those currently prevailing in Rodrigues. In the relatively wet island of Mauritius for example it would be hard to sell a project for the clearance of invasive alien plants on the issue of water security. However, there might be other entry points that could be utilised to allow an up-scaling of restoration work. In the case of Mauritius it could be

employment generation, much needed for the sugar estate labourers now being laid off because of the increasing mechanisation of sugar cane production. Other islands, no doubt, will have analogous entry points through which IAS management can be mainstreamed. The initiation and implementation of such projects depends on experts in specialist fields making the effort to show that their work is relevant to the wider society of which they are a part. If this can be done IAS management can be carried out on the scale necessary to make efforts ecologically and financially sustainable in the highly invaded islands of the Western Indian Ocean.

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Poster: An assessment of the potential for rodent eradication in the Tristan da Cunha Islands Group

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An OTEP project, managed by the Tristan da Cunha Natural Resources Department, Royal Society for the Protection of Birds & University of Cape Town.

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Project Background

Tristan da Cunha is the most important UKOT for biodiversity conservation, holding the highest numbers of endemic and globally threatened species. The archipelago is perhaps the most important breeding site for seabirds in the world, holding millions of pairs of over twenty species, including three endemic species. There are also five endemic landbirds, and numerous endemic plants and insects.

The two largest islands in the Tristan da Cunha group – Tristan da Cunha and Gough Island, have introduced rodents – Ship Rats *Rattus rattus* and House Mice *Mus musculus* on the former, and house mice only on the latter. Introduced rodents have devastating effects on the biota of oceanic islands, and are the primary cause of historical bird extinctions. They are thought to have had, and to continue to have, a profound impact on the biodiversity of Tristan and Gough. The Gough Island World Heritage Site is under threat of losing the biodiversity values for which it was inscribed. The draft Tristan da Cunha Biodiversity Action Plan, produced through stakeholder workshops in Tristan and the UK, cites rats as the most important negative factor operating in the terrestrial environment, and recommends an assessment of potential actions to remove this threat. The revised Gough Island Nature Reserve Management Plan cites mice as a major negative factor affecting the island's biota. Consequently, the Natural Resources Department of Tristan has requested that an investigation into possible responses to this problem be carried out. An assessment of the options for reducing or removing the impact of rodents on these islands is being produced, with the aim of preventing further biodiversity losses, and permitting restoration of native ecosystems.

Activities and Results

1. A Review of the Impacts of rodents on Tristan da Cunha and Gough

A desktop synthesis of what is known, and can be inferred about the overall impact of rodents on the islands has been produced. This includes historical impacts, ongoing impacts and likely future impacts, as well as assessing the benefits for biodiversity conservation of reducing rodent impacts. It also indicates significant gaps in information that require new fieldwork. This Review will shortly be formally published in the RSPB Research Report Series (contact Geoff Hilton for a copy).

The rats on Tristan da Cunha (in combination with predation by cats and humans, which has now ceased) are thought to have greatly reduced the size of seabird populations, which were once massive, but are now very small. Some seabird species are probably already extirpated from the island. Rats may also have been responsible for the extinction of two endemic landbirds. Very little is known about the impacts of rodents on the native biota of the island. Although very under-studied, it seems probable that the Ship Rat on Tristan has led to local population reductions and possibly extinctions of native plants (especially tussock grass) and invertebrates. No recovery of native biota can be foreseen without removing rat impacts. Rapid

recovery and recolonisation of native biota is likely if rat impacts are removed.

Gough Island is in a more natural state than Tristan, and historic rodent impacts are far less obvious. Ongoing and future impacts are however, much more severe. Impacts on plant and invertebrate communities are as yet unknown, but are thought likely to occur, based on studies from other islands. Two species of endemic flightless moths may be at particular risk. The House Mouse on Gough has been recorded preying upon and killing chicks of the Endangered Tristan Albatross *Diomedea dabbenena*, Vulnerable Atlantic Petrel *Pterodroma incerta* and Great Shearwater *Puffinus gravis*. Circumstantial evidence suggests strongly that it also preys upon eggs and chicks of the Vulnerable endemic Gough Bunting *Rowettia goughensis*. Breeding success of both the albatross and the petrel are too low to sustain their populations. Impacts on other bird species are currently unknown, but are predicted to occur to all the winter-breeding species (when avian material peaks in mice stomachs), as well as to the smaller burrowing petrels, especially the storm-petrels and Common Diving-petrel *Pelecanoides urinatrix*. If the House Mouse is removed from Gough Island, recovery of impacted flora and invertebrates is expected, and a recovery of affected bird populations is expected, leading to an improved conservation status, as well as the maintenance of plant and invertebrate communities indirectly through manuring and burrowing activities.

In conclusion, rodents (in conjunction with other anthropogenic factors) have destroyed much of Tristan's biodiversity interest, especially seabirds, but there is potential for recovery of most populations over time if rodent impacts are removed. On Gough, the impacts of mice are perhaps as severe, but are yet to be fully played out, with massive population reductions and extirpations forecast for the future. Again, a major recovery is expected if mouse impacts can be removed.

2. An assessment of the feasibility of available options, with identification of preferred option

An expert consultant was recruited to conduct a full feasibility study for Tristan da Cunha in 2005. He made a site visit, as well as inspecting relevant facilities in Cape Town (the port of boat departure for Tristan). He assessed various options, namely: (1) begin planning for an eradication of rats or rats and mice; (2) strengthen biosecurity/quarantine arrangements to prevent further introductions; (3) localised, ongoing control of rodents in key sites where their impact on bird populations is particularly important; (4) conduct all necessary background research, and then wait (e.g. for 10-20 years) for improvements in rodent control/eradication technology. This Feasibility Study is available as an unpublished report from Geoff Hilton.

The consultant was unable to visit Gough Island in person. Based on discussions with biologists who had worked there, and analysis of key features of the island (size, terrain, biota, climate, human population and livestock), the consultant produced an interim feasibility study for Gough, but reported that a site-visit was necessary to confirm his conclusions. The draft feasibility study for Gough is included with the Tristan study.

A site visit to Gough, with a view to producing a formal and definitive feasibility study, will take place in September 2007.

The Tristan Feasibility Study concluded that the eradication of rodents is likely to have significant ecological, financial and social benefits for the island, far greater than any practical level of on-going control. The eradication of rats and mice from Tristan appears technically feasible, but presents significant challenges, with an unprecedented combination of issues. The prospects for successful eradication appear to be very high for Ship Rats and possible, but with a lower expectation of success, for House Mice. If successful, it would be the largest island from which either Ship Rats or House Mice, or the two in combination, have been eradicated, although larger islands have been cleared of Norway Rats *Rattus norvegicus*. Aerial broadcast of cereal-based pellets containing the anticoagulant toxin brodifacoum using helicopters equipped with bait-dispensing buckets and Differential GPS would be used. There are particular issues related to potential effects on the human inhabitants of the island, on their livestock, and on several important wildlife species. There are also issues surrounding anthropogenic food resources for commensal rodents and quarantine measures. All these issues must be managed and overcome, with full community support, before any eradication is attempted. A preliminary estimate of costs of an eradication operation on Tristan is in the order of £ 1.5 to 2 million.

The interim Feasibility Study for House Mice on Gough concluded that in order to protect the

globally important Tristan Albatross and Atlantic Petrel populations the eradication of mice from Gough is desirable, and the most practical long-term solution to the current problem of mouse predation. Aerial broadcast of brodifacoum would again be required. Gough Island presents significant challenges for potential mouse eradication. It is considerably larger than any island successfully cleared of the House Mouse to date, while it also has significant issues in relation to its isolation, climate and behavioural aspects of its mouse population. There are more unknown aspects surrounding the eradication of mice from islands, largely because less experience has been accumulated in mouse eradication technology. There are significant potential risks to some non-target species.

3. Produce a detailed, costed plan of action for preferred option

Having reached a consensus at the stakeholder workshop (see below) that eradication of rats on Tristan da Cunha was feasible and desirable, the external consultant was contracted to produce a detailed Operational Plan to conduct such a programme.

This Operational Plan, currently in late-draft form, describes the planning, eradication and follow-up stages. It discusses the requirements for the project team, helicopters, ships, poison-bait, bait-sowing, planning and logistics, health and environmental safety, and contingency operations.

If the Gough Island Feasibility Study similarly suggests a clear way forward, a second Operational Plan will be commissioned.

4. Develop agreement among stakeholders regarding the preferred options

A stakeholder workshop was held in Cape Town in October 2005, to review the Feasibility Study for Tristan and the Review of Impacts, evaluate the options, and agree on the preferred course of action. The workshop involved Tristan Natural Resources Department, Tristan Administrator, Tristan Island Council, RSPB, University of Cape Town and the external consultant. The workshop report is available as an unpublished report from Geoff Hilton.

The workshop participants reached consensus that (1) an Operational Plan for the eradication of rodents from Tristan should be commissioned without delay, using project funding. (2) a visit to Gough by an expert consultant, in order to produce a definitive Feasibility Study for that island, should be urgently organised.

The Tristan Biodiversity Officer (an employee of the Natural Resources Department) will engage with the Tristan Community during 2007 to inform them of the study's results and the implications of potential actions against rodents.

When all Feasibility Studies and Operational Plans are complete – probably in early 2008, a technical expert will visit Tristan to discuss them with the local community. They will be asked to describe the potential benefits and costs of the potential actions, to gauge support, and to answer queries.

5. Conduct ecological research on rodents and their impacts to inform planning

To facilitate the development of a detailed plan, the ecology of the rodent species needs to be well understood. An RSPB Senior Research Assistant and Natural Resources Department staff undertook an initial assessment of rat ecology on Tristan da Cunha in 2005-6. Similarly, on Gough Island, an RSPB-funded PhD (2003-7) and an additional tranche of fieldwork in 2005-6 is addressing these data requirements.

The rodent ecology work on Tristan has confirmed the breeding phenology of the rodent species, which is required information for planning an eradication. It has also determined the relative abundance of rats in different habitats on the island, which helps with planning baiting requirements. It also enhanced our knowledge of the current status of bird species on the island, uncovering various remnant colonies, and establishing ongoing monitoring protocols.

Research into the mouse population on Gough is ongoing. The species reaches unprecedented densities and body size. Diet is complex and seasonally variable. The reasons for localised variation in the extent of seabird predation are being explored. Current investigations into home-range size will help evaluate the poison bait density requirements.

Poster: An experimental assessment of the impact of rats on the biodiversity of the Centre Hills, Montserrat

Geoff Hilton, RSPB

Hilton, G. 2007. An experimental assessment of the impact of rats on the biodiversity of the Centre Hills, Montserrat. pp 229-230 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Research forming part of the Darwin Initiative project 'Empowering the people of Montserrat to conserve the Centre Hills', managed by the Montserrat Ministry of Agriculture, Lands, Housing and Environment, Montserrat National Trust, Montserrat Tourist Board, Royal Society for the Protection of Birds, Durrell Wildlife Conservation Trust and Royal Botanic Gardens, Kew.

Geoff Hilton, Royal Society for the Protection of Birds, c/o Sociedade Portuguesa para o Estudo das Aves (SPEA), Rua da Vitória nº 53, 3º Esq., 1100-618 Lisboa, Portugal. geoff.hilton@rspb.org.uk

Project background

The bulk of Montserrat's remaining forest cover forms a more or less contiguous block of *ca*.14 km^2 in the Centre Hills range, ranging from sea-level to 740 m asl. This forest supports populations of many globally threatened and/or endemic species, and is the focus of most conservation efforts on the island. Previous work, particularly the 'Emergency Conservation of the Montserrat Oriole' project, has suggested that one of the main threats to the biodiversity of the forest is invasive alien species (IAS). Prominent among these IAS are rats (both Ship Rats *Rattus rattus* and Norway Rats *R. norvegicus*), which are abundant in the Centre Hills.

Predation by Ship Rats is known to be the major cause of nesting failure in the 'critically endangered' endemic Montserrat Oriole *Icterus oberi*. Rats are also known to attack the 'critically endangered' Mountain Chicken *Leptodactylus fallax* (a giant frog) and to predate nests of the globally 'vulnerable' Forest Thrush, but the magnitude of impacts on the populations are not known. However, based on evidence from other islands, including neighbouring Antigua, rats might be having widespread pernicious effects on native biodiversity. Rat control or eradication on islands has led to increases in plant regeneration and ground flora, and increases in populations of macro-invertebrates, reptiles, amphibians and birds, although such recoveries are neither universal nor well-studied.

Based on this, some form of rat control or exclusion for the benefit of biodiversity might become a management target for the Centre Hills. However, such management is likely to be costly. It is therefore very important to determine the real impacts of rats, to find out whether any expenditure on such management would be justified. It is also important to understand the reasons why rats are so abundant, since this may help with the design of management recommendations.

There is also major concern about the potentially devastating impacts of introduced pigs *Sus scrofa*, while little is known about the scale of adverse impacts caused by feral cats *Felis catus* and feral goats *Capra hircus*, and a number of invasive plant species. The research team of the Darwin project is attempting to clarify the scale of problems caused by these species.

Activities and Results

An experimental study of the impact of rats on the biodiversity of the Centre Hills

The study site, in the north-west of the Centre Hills, is divided into three areas. A central 'experimental area' will be the subject of rat control effort, while two flanking (but not immediately adjacent) 'control areas' will be left untouched. The experiment will have three phases: baseline data collection, knockdown, and post-knockdown. The baseline data collection comprises a period in

which data on the abundance of various taxa are gathered in the study site, while rats are not controlled. Following this, the rats in the experimental area will be knocked down using a combination of trapping and poison-baiting. Following an initial intensive phase, involving poison-baiting, low (but not zero) rat numbers in the experimental area will be maintained using trapping. During this knockdown phase, the rats in the two control areas will be left uncontrolled. Data on biodiversity will continue to be gathered through this period. Finally, the rat control will cease in the experimental area, and we will continue to monitor biodiversity as rat numbers return to normal levels.

The baseline data collection will last for five months. The knockdown and post-knockdown phases will last for approximately two years.

Data on the abundance of plant seedlings, reptiles and amphibians (including Mountain Chickens), macro-invertebrates will be gathered, plus information about bird nesting success, so that the diverse potential effects of rats can be evaluated.

Although the practical challenges are formidable, we hope that the experimental approach taken here will provide a robust test of whether rats affect the biodiversity of the Centre Hills. We will effectively be testing for a divergence in biodiversity trends between the control and experimental areas after the knockdown takes place, followed by a convergence once the rat control ceases.

An assessment of rat ecology in the Centre Hills

Rat trapping lines have been established in widespread parts of the Centre Hills. This gives information on abundance of the two rat species, and how it varies across the hills and over time. We are also dissecting these rats, to look at diet, and breeding seasonality.

Initial analyses, conducted for the 'Montserrat Biodiversity Assessment' co-ordinated by Durrell Wildlife Conservation Trust, indicates that Norway Rats are most abundant in the lower altitude areas and around forest-edges, whereas Ship Rats are abundant throughout. Interestingly, both species tend to be most abundant in areas where there are small agricultural clearings and large (mostly non-native) fruit trees. This possibly provides a hint about why rats are so abundant in the Centre Hills.

Poster: Ascension Island Seabird Restoration Project

Tara Pelembe, Raymond Benjamin and Anselmo Pelembe, Ascension Island Government Conservation Office

Pelembe, T., Benjamin, R. & Pelembe, A. 2007. Ascension Island Seabird Restoration Project. pp 231-233 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

The introduction of cats on Ascension Island by human settlers since the 1800s has resulted in greatly reduced populations of breeding seabirds, and the extinction of a rail and a heron. Despite this, Ascension is still the most important breeding station for seabirds in the tropical Atlantic. The Ascension Island Seabird Restoration project, starting in 2001, aimed to remove the feral cats to enable recolonisation of the main island. This paper describes the success of this project, and gives information on the lessons learnt.

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The Problem

Islands around the world have suffered dramatically as a result of mammalian introductions, often resulting in insular avian extinctions. The south Atlantic island of Ascension is no exception. Ascension Island lies 7◦57S, 14◦22W. It is a small volcanic island with an area of 97 square kilometres. Evidence from historic records, subfossil evidence and distribution of guano deposits indicates that once large colonies of seabirds nested on the main island of Ascension (Ashmole 1963a, Olson 1977, Blair 1989). Humans settled in the 1800s and their subsequent introduction of cats led to the extinction of 2 avian species, a heron and a rail. Similarly, there were large seabird population declines (Ashmole *et al.* 1994). Even though populations are greatly reduced, Ascension is still the most important breeding station for seabirds in the tropical Atlantic. Stonehouse (1962) estimated these remaining seabird population sizes as follows:

Estimated breeding populations of Seabirds on Ascension in1962:

Red-footed Booby *Sula sula*	30
Brown Booby *Sula leucogaster*	2000
Masked Booby *Sula dactylatra*	9000
Ascension I Frigatebird *Fregata aquila*	6000
Red-billed tropicbird *Phaethon aethereus*	500
Yellow-billed tropicbird *Phaethon lepturus*	2000
Sooty Tern *Sterna fuscata*	750000
Fairy tern *Gygis alba*	2000
Black Noddy *Anous tenuirostris*	75000
Brown Noddy *Anous stolidus*	1000
Madeiran Storm Petrel *Oceanodroma castro*	3000

Ten of these eleven native seabird species (excluding the Sooty Terns *Sterna fuscata*) were limited to a few small colonies on 14 small offshore islands, inaccessible cliffs and the 5 ha Boatswainbird Island (BBI), the latter being the sole global breeding site for the endemic Ascension Frigatebird *Fregata aquila*. Sooty Terns *Sterna fuscata* continued to nest on the main land although their numbers were greatly reduced by the presence of feral cats. Their continued presence is assumed to be a result of their non-annual 9.6 month breeding cycle which includes 4-5 months away from the island. This species has been studied separately by the Army Ornithological Society and will not be reported in this paper.

What was done about the problem

In an attempt to increase breeding seabird numbers, the Ascension Island Seabird Restoration Project was initiated in 2001. It aimed to remove the primary seabird predators: feral cats from the main island of Ascension, thus providing an unlimited number of nesting sites for all seabird species. It was anticipated that this would result in recolonisation of the main island by seabirds. Recolonisation by the IUCN redlisted endemic Ascension frigatebird was a primary goal.

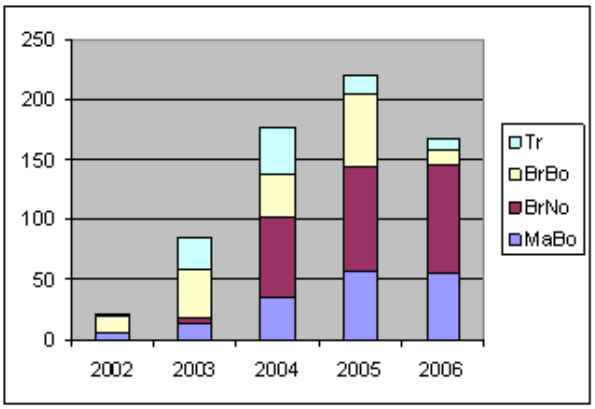
Masked Booby adult

Masked Booby chick

The Ascension Seabird Restoration project marks an important landmark in conservation history. It is the first time that feral cat eradication has been attempted on a large island with a significant human population, while retaining domestic cats. There was significant interest expressed in the project from other Overseas Territories and internationally.

The feral cat removal proved successful and cat numbers declined rapidly. Most feral cats were gone by 2003 and the last confirmed feral cat was recorded in February 2004. (Bell et al. in prep). Since February 2004 the island has been continuously monitored and no feral cats have been detected.

Seabird recolonisation of the main island occurred almost immediately in 2002. Five species of seabirds have recolonised the main island of Ascension during and post cat-eradication: Masked Boobies, Brown Boobies, Brown Noddies, Red-billed and White-billed Tropicbirds. The two tropicbird species have been combined for the purposes of analysis as there have only been 3 breeding attempts by the Red-billed tropicbird: 1 in 2004 and 2 in 2005. Figures for 2006 are incomplete as data collection stopped at the end of May.



Population trends of recolonising seabirds on Mainland Ascension Island

Masked Boobies, Brown Boobies and tropic birds started to return in 2002, the year that cat eradication was initiated. The Brown Noddy return was a year later. Each species displays a different increase trend: the number of Masked Boobies returning to nest on the mainland has increased annually by approximately 20 birds; the number of Brown Noddies by differing intervals 4, 59, 20; the number of Brown Boobies and Tropic birds has not shown an annual increase after with the former decreasing in 2004 and the latter in 2005. There is an overall annual increase in the number of seabirds returning to the mainland, however it is not a total standard annual increase (2003= 63, 2004= 92, 2005 = 44).

It should be noted that the highest total annual increase is in 2004, the first year after the majority of feral cats has been eradicated

Lessons learnt

The success of the seabird restoration project was the result of team work on a large scale, there were a large number of stakeholders, various organisations directly involved and the people of Ascension whose lives were affected by the project.

Although the project took longer than expected, the time taken for the feral cat eradication on Ascension was comparatively low to similar islands. Many lessons were learnt including:

1. The importance of enlisting high-level political support. We would never have secured the funding for the project without the support of the Administrator on Ascension.

2. We underestimated the length of time needed to remove all the feral cats and consequently the resources required for the exercise. The initial

funding catered only for the eradication stage and not the long term monitoring for either presence/absence of cats nor for the return of seabirds, so further, limited funding had to be sought.

3. Ascension has extremely rugged, undulating terrain, which is very different from situations we or others whose advice we sought, are used to. This posed challenges to the eradication methods employed.

4. Radio tracking should have been carried out before the start of the project to gain a better understanding of the distance domestic cats on Ascension will travel and to determine the extent of the buffer zone. For example, had the buffer zone been 2km rather than 1km (the distance advised by RSPCA/CPL) domestic cat deaths would have been avoided.

5. Although it would have taken more time initially, local people should have been involved in the feral cat eradication team from the beginning of the project to build support and capacity on the island. This would have resulted in a trained cadre of persons remaining on Ascension when the New Zealand team left to take forward the feral cat monitoring and respond to contingencies. Instead, the New Zealand team contract had to be extended at the project's end to train persons on the island.

6. Consulting CPL and the RSPCA on methods used for cat eradication to ensure feral cats were removed in as humane manner as possible was essential. While neither organisation could fully support the project, they were very helpful in offering advice. On the only occasion this project was reported in the UK press, they were supportive. On Ascension, the Ascension Island Society for the Prevention of Cruelty to Animals, acted as the focus for all animal welfare issues. Without their support the project would have had immense problems and perhaps failed.

Poster: Spatial and temporal patterns of seabird recolonisation of mainland Ascension following cat eradication

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Pelembe, T., Ratcliffe, N., Bell, M., White, R. & Sanders, S. 2007. Spatial and temporal patterns of seabird recolonisation of mainland Ascension following cat eradication. p 234 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Ascension Island was formerly home to large seabird colonies, but the introduction of cats in the 1800s led to rapid population declines. Relict populations survived on inaccessible cliff ledges and offshore stacks, the largest of which is Boatswainbird island. In 2001 a feral cat eradication programme was initiated and the last known feral cat was removed from the mainland in March 2004. Seabird recolonisation of the mainland was first recorded in May 2002 and numbers have increased steadily since. Most species have occupied main island sites immediately adjacent to existing colonies, although Masked Boobies exhibit a higher degree of dispersal. The species that have recolonised are those that previous work suggested were most stressed for breeding space: Masked Booby *Sula dactylatra*, Brown Booby *S. leucogaster*, Brown Noddy *Anous stolidus* and White-tailed Tropicbird *Phaethon lepturus*, but to date there is no evidence of the endemic Ascension Frigatebird *Fregata aquila* recolonisation. Overall breeding success was relatively low compared to estimates elsewhere in each species range, and possible reasons for this will be discussed. We developed population models to assess demographic mechanisms of recolonisation. These indicate that a putative floating population that might have colonised the mainland rapidly did not in fact exist, probably owing to cat predation of recruiting birds attempting to recolonise the mainland prior to eradication.

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Poster: Invasive species and their impact on the Wirebird

Cathy Hopkins and Gavin Ellick, St Helena National Trust

Hopkins, M.C. & Ellick, G. 2007. Invasive species and their impact on the Wirebird. pp 235-236 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

The St Helena Wirebird, critically endangered and endemic to St Helena, has seen a population decline of 43% in the last 5 years to about 220 adults. Research findings so far indicate that habitat degradation, scrub invasion and feral cats are key factors in the decline. Trial habitat restoration and controlled grazing are being undertaken to increase the area suitable for the birds.

Cathy Hopkins, Director, SHNT and **Gavin Ellick** Conservation Officer, St Helena National Trust, Broadway House, Main Street, Jamestown STHL 1ZZ, St Helena. sth.nattrust@helanta.sh

The St Helena Plover (Wirebird) is a Critically Endangered species, endemic to St Helena and with a population of about 220 adults. It is found in semi-desert, dry pasture and wet pasture areas. On Prosperous Bay Plain (semi-desert) these birds are found around and above the Central Basin area. It also favours other habitats such as Deadwood Plain, Bottom Woods, Woody Ridge and Man & Horse – dry pastures; and Broad Bottom – a wet pasture. In the last 5 years we have seen a significant decline of 43% in the population. The main causes appear to be habitat degradation due to reduced grazing, the proliferation of introduced predators and invasive plants. Of the latter, Wild Coffee *Chrysanthemoides monilifera*, Lantana *Lantana camara*, Gorse *Ulex europaeus*, Creeper *Carpobrotus edulis* and Bull Grass *Juncus capillaceus*, are most evident on Deadwood and Bottom Woods areas.

Under the auspices of an OTEP/ RSPB funded project, the SHNT is undertaking research into the breeding distribution and success of the Wirebird in these differing habitats and the causes of the decline, with the aim of increasing its population to a higher and stable level. The co-operation of the local cattle syndicate on Deadwood Pasture and the Agriculture & Natural Resources Department as well as private sector cattle and sheep owners is much appreciated by the SHNT.

From research carried out since the project's start in April 2006, we have found that feral cats are likely to be the most important predator and a key factor in the decline of this species as they use the scrub cover to approach and take chicks. Removing the scrub should enable the Wirebirds to nest more safely.

The picture below shows a wirebird getting up from eggs – the nest is a scrape in dried creeper and the bird would cover the eggs when leaving them



Invasive bull grass, disliked by the wirebird; gorse invading pasture; and kikuyu grass overgrazed and interspersed with bare ground, preferred by the wirebird

However, the invasive plants give the greatest cause for concern across the island, particularly in the semi-desert and dry pasture habitats. All those mentioned above currently give rise for concern. Of them, the greatest proportionate gain could probably be achieved on the Bottom Woods area if better land management was put in place. This area held 44 birds in 1989 but in 2005 there were only 5 birds recorded - a huge drop in numbers. It is likely that this decrease in population occurred because of the invasive scrub gradually taking over the area. Prickly Pear *Opuntia* sp., *Carpobrotus*, *Lantana* and *Aloe* bushes are widespread. Since April, we have found 16 birds where there is less scrub and survey work found 5 nests with 4 chicks (unfortunately apparently taken by feral cats).

On Deadwood Pasture there is evidence of widespread Bull Grass in some areas with other areas invaded by Lantana, Coffee and Everlasting *Helichrysum bracteatum*. Gorse is also prevalent. The winter rains (July-August) has seen all of these invasive species growing vigorously.

Of the other pastures where survey work is being carried out, Woody Ridge has a small amount of Wild Mango *Schinus terebinthifolia*, Gorse and many other weed species. However, the management of this pasture in terms of cattle rotation keeping the sward short is good. On Man & Horse pasture we have a lot of Bull Grass and Lantana with a small amount of Gorse.

The importance of reducing the spread of the invasive weeds cannot be over-emphasised in respect of the benefits to the Wirebird - research shows that it is a “fussy” bird when it comes to choosing nesting sites. It will not nest where its circle of vision is limited and, given the height of the invasives, this means that where they are found, the Wirebird is generally absent or in reduced densities. Even grass left to grow above a few inches reduces the potential nesting area for the Wirebird as well as severely reducing their feeding efficiency.

As part of the SHNT/OTEP/RSPB project, a trial restoration project is being undertaken on Deadwood Pasture. This includes the removal of invasive weeds from certain pastures combined with controlled grazing on these. On another paddock, just controlled grazing is taking place. We wish to see how different management techniques affect the Wirebird breeding success. We believe that this part of the project will increase the area of suitable nesting sites whilst improving the pasture for the cattle. We would wish to build upon this trial and welcome the opportunity to access funding for further work under the EU Invasives Species project.

Poster: Invasive species control (Roseapple *Syzygium jambos*) and restoration of the threatened native flora of Pitcairn Island, South Central Pacific Ocean

Noeleen Smyth, Steve Waldren, Trinity College, Dublin, Naomi Kingston, National Parks and Wildlife Service, Jay & Carol Warren, Pitcairn Island

Smyth, N., Waldren, S., Kingston, N., Warren, J. & Warren, C. 2007. Invasive species control (Roseapple *Syzygium jambos*) and restoration of the threatened native flora of Pitcairn Island, South Central Pacific Ocean. p 237 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

The introduced Roseapple Syzygium jambos has grown and spread considerably, and regeneration of native species is inhibited under its dense canopy. A native plant nursery provided plants to re-introduce in trial plots where Roseapple plants had been removed by chemical treatment. Using these results, a detailed management plant for the control of Roseapple is currently being developed.

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Background

Roseapple *Syzygium jambos* was originally introduced to Pitcairn Island as a source of fuel-wood in the 19th century. The decline in the local population coupled with modernisation and use of gas cookers has meant that Roseapple has grown and spread considerably and now dominates much of the vegetation on the north side of the island beneath the main ridge. Regeneration of native species is inhibited under the dense canopy of Roseapple.

Experimental treatments

80 trial plots (10x10m^2) were selected randomly in areas dominated by Roseapple. Baseline information on Roseapple (seedling, sapling and adult density) was recorded. Soil fertility, canopy cover and details of any remaining native vegetation also were recorded. Investigation into the proportion of Roseapple present in the soil seed bank was carried out. A nursery was established to propagate native and rare species to replace Roseapple in trial plots and increase the small numbers of severely threatened endemic plant species.

Results to date

Data on planted native species survival and growth rate, and Roseapple mortality were recorded from experimental plots in 2005 & 2006. The overall native plant survival rate in plots was high (63.37%). One thousand nine hundred and twenty-seven sapling and adult plants of Roseapple were treated chemically and only five of these showed signs of active re-growth in 2005 (99.75% mortality). Secondary invasion by other invasive and weedy plant species was found to be problematic in plots where Roseapple was cut and the stumps chemically treated (80.80% weed cover).

Future work

A detailed management plan for the control of the species is currently being developed and the plan will provide an exit strategy for the initial investigative phase and provide the framework to secure more funding for more extensive control of Roseapple on Pitcairn Island.

Publications

Waldren, S., Kingston, N., Smyth, N., Warren, J. & Warren, C. 2005. Integrated plant conservation on Pitcairn Island, South Central Pacific Ocean. Journal of Botanic Gardens Conservation International. Special Biodiversity Issue 2 (1): 22-24.

Waldren, S., Kingston, N., Smyth, N., Warren, J. & Warren, C. 2004. Plant conservation activities on Pitcairn Island. Flora English Nature. Summer 2004: 14-15.

Poster: Invasive Alien Species in Bermuda – The Current Situation

Anne F. Glasspool, W. Sterrer, Bermuda Zoological Society, and J.A. Ward, Department of Conservation Services, Bermuda

Glasspool, A.F., Sterrer, W. & Ward, J.A. 2007. Invasive Alien Species in Bermuda – The Current Situation. pp 238-242 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Whilst Bermuda's marine environment has largely been unaffected by invasive alien species, Bermuda's terrestrial biota have been drastically altered. At least 1200 exotic species (mainly flowering plants, insects, spiders, snails, birds, reptiles and amphibians) have become naturalised. This means that, of more than 1600 resident terrestrial plant and animal species, only 27% are native. Verrill (1902) estimated that "perhaps 90% of all the insects have been introduced by man, since settlement". Amongst the plants, at least 22 considered invasive are now a dominant feature of the 33% of Bermuda's land area that remains undeveloped. And 23 of the "100 World's Worst Invasive Alien Species" (www.issg.org/database) occur in Bermuda. This poster details the current situation, considers pathways of entry including accidental and deliberate introductions, and outlines the regulatory framework including; prevention of introductions, control and eradication and education and public awareness.

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Introduction

The dramatic increase in global trade and travel over the last few decades has led to rapid acceleration of alien species movements. Bermuda now imports nearly everything it needs (including tourists and foreign workers). In 1999 an estimated 300,000 metric tonnes of goods were imported, of which the majority arrived by container ship. In the same year, there were 6,024 aircraft landings with 481,274 passengers, and 1,550 cruise ship and yacht arrivals carrying 195,586 visitors.

Whilst the Island's marine environment has largely been unaffected by invasive alien species (the most notable exception being the Pacific Lionfish), Sterrer *et al.* (2004) report that Bermuda's terrestrial biota have been drastically altered. At least 1200 exotic species (mainly flowering plants, insects, spiders, snails, birds, reptiles and amphibians) have become naturalised, which means that of more than 1600 resident terrestrial plant and animal species only 27% are native. Verrill (1902) estimated that "perhaps 90% of all the insects have been introduced by man, since settlement". Amongst the plants, at least 22 considered invasive are now a dominant feature of the 33% of Bermuda's land area that remains undeveloped. And of "100 of the World's Worst Invasive Alien Species" (www.issg.org/database), 23 species occur in Bermuda.

Pathways of Entry - A Brief History of Alien Invasions in Bermuda

Since the time of the first human visitors, Bermuda's shores have been assaulted by an almost con-

Changes in species composition since human colonisation for the better-known taxa of terrestrial and freshwater plants. (From Sterrer et al, 2004).

Insects: The total for introduced species excludes interceptions and isolated records
Flowering Plants: The total for introduced species only includes naturalised, self-propagating species

Terrestrial Species	Endemic	(of which extinct)	Non-endemic Native	Introduced/ Naturalised	Total spp.	% Aliens
Flowering plants	10	0	150	371	531	70
Other plants (ferns, mosses)	6	0	15	17	38	45
Mollusks	18	6	6	33	57	58
Insects	44	16	172	703	919	76
Spiders	2	0	5	34	41	83
Amphibians	0	0	0	3	3	100
Reptiles	1	0	0	4	5	80
Birds	4	3	7	9	20	45
Mammals	0	0	0	4	4	100
Total	**85**	**25**	**355**	**1178**	**1618**	**73**

tinual procession of invaders as detailed by Sterrer *et al.* (2004). This history has shown that there are three main pathways by which an invasive alien species can enter Bermuda and establish itself:

1. Accidental introductions

Perhaps the most notorious, and ecologically catastrophic local example of an accidental introduction was that of the Oyster-shell scale *Insulaspis pallida* and the Juniper scale, which arrived on shipments of conifers and which proved near-fatal to Bermuda's endemic Cedar *Juniperus bermudiana* in the 1940s. By the 1950s, an estimated 90% of the Island's Cedars had succumbed, requiring a massive effort of removing dead trees, and replacing them with imports. The Australian Whistling Pine *Casuarina equisetifolia* became the stand-in of choice, and today it dominates much of Bermuda's landscape. Many other alien species were mass-planted in the 1950s, from coconuts to hibiscus, Indian Laurel, Natal Plum and Norfolk Island Pine, setting the stage for a new wave of invasive aliens of which the Brazil Pepper was to become the most notorious.

2. Deliberate introductions

As a Food Resource **-** It was a passing visit by a Spanish vessel in the mid 1500s that saw the first deliberate introduction of an invasive alien species into Bermuda, in this case, the hog, left ashore as a future food resource for later visits, which wreaked havoc on the native flora and fauna.

For Ornamental Purposes **-** By the time of Verrill's (1902, 1907) and Britton's (1918) pioneering surveys of Bermuda's biotas, the replacement of native flora and fauna with exotics was quite advanced. The once dominant endemic Cedar *Juniperus bermudiana* had been decimated, first by burning (in the early 1600s, to rid the Island of rats), then increasingly for its value in export and shipbuilding, which by the late 1800s left large tracts of the Island clear-cut, with opportunities for deliberate replacement or invasion by exotic plants.

As a Biological Control **-** The best local examples of biological control were the efforts to stem the cedar blight. Between 1946 and 1951, several million natural insect predators belonging to more than 100 species (mostly coccinellid beetles and parasitoid wasps) were introduced from all over the world. An entomological survey in the 1980s recorded 9 coccinellid species as established (Gordon & Hilburn 1990). When it was realised

that coccinellid beetles were heavily preyed on by previously introduced lizards (*Anolis grahami* in particular), 200 specimens of the Kiskadee Flycatcher *Pitangus sulphuratus* were brought in from Trinidad in 1957 to control the anoles. The Kiskadee increased explosively, becoming a major threat to other birds, and being implicated in the extinction of the endemic Cicada in the late 1990s.

Species brought in to be held in "captivity", i.e. pets, which then escape/are released into the wild - Pets, if not wanted any more, have occasionally been released or escaped 'back' into the wild. The most notorious of these is the red eared slider terrapin *Trachemys scripta elegans* which was introduced through the pet trade and now resides in all of the Island's ponds, posing a potential threat to native fauna.

Reintroductions - There have been two documented reintroductions locally; the large West Indian Topshell *Cittarium pica*, known as a common fossil, and the Yellow-crowned Night Heron *Nyctanassa violacea*, of which an endemic form had been breeding here in the 1600s. Despite some concerns about the extent to which the population of Common land crabs has declined with the re-introduction of the Yellow-crowned Night heron, neither species has been documented as being ecologically disruptive.

3. Via vectors for spread sometime after an alien species has been introduced

In many cases, invasive alien species become pests only after a considerable time-lag during which they persist in small numbers until an outbreak is triggered. The giant Indian Laurel tree *Ficus retusa*, extensively planted in the 1950s as a replacement of the endemic cedar, remained sterile until its pollinator, the fig wasp *Parapristina verticillata*, arrived accidentally in the early 1980s. This strangler fig has now become an island-wide problem, its hemi-epiphytic seedlings sprouting from roof gutters, cracking stone walls and water tanks, and killing palms and cedar trees.

The Current Picture Summarised

Bermuda currently plays host to 23 of the IUCN's listing of the Top 100 Worst Invasive Alien Species. Although one of these is a native (the comb jelly *Mnemiopsis leidyi*), and several others are not (yet?) locally invasive (the African tulip tree *Spathodea campanulata*; the Little Fire ant *Wasmannia auropunctata*; and domestic species such as goat, pig, and rabbit), this still leaves 17 species that are invasive here as elsewhere, including the water hyacinth *Eichhornia crassipes*, Kudzu *Pueraria lobata*, the Brazilian Pepper tree *Schinus terebinthifolius*, Giant Reed *Arundo donax*, Lantana *Lantana camara*, Leucaena *Leucaena leucocephala*, Wedelia *Wedelia trilobata*; the Argentine ant *Linepithema humile*, Big-headed ant *Pheidole megacephala*, Rosy Wolf snail *Euglandina rosea*, Sweet Potato whitefly *Bemisia tabaci*, the Western mosquitofish *Gambusia affinis*, Giant toad *Bufo marinus*, Starling *Sturnus vulgaris*, Red-eared slider *Trachemys scripta*, Domestic cat *Felis catus*, Mouse *Mus musculus* and Ship rat *Rattus rattus*.

Between 1998 and 2000 the Bermuda Biodiversity Project conducted 1,440 surveys of Bermuda's vegetation (Anderson *et al.*, 2001, Glasspool *et al.*, in prep). In total, 394 plant species were recorded, of which 112 were native, and 282 non-native. As might be expected, anthropogenic habitats (Wayside, Hedgerow, Arable, Garden and Golf Course) are the most heavily invaded by aliens. Coastal habitats and Peat Marshes are relatively uninvaded, at least in numbers of aliens, and natives retain dominance. By contrast, Upland habitats are a

Alien plant species considered locally invasive from the findings of the Bermuda Biodiversity Project Survey (in prep).

Participants in the 2003 Darwin-funded Invasive Alien Species Workshop also identified the following species as cause for concern; Morning glory *Ipomoea indica*, Schefflera, Murray red gum, Madagascar olive *Norhonia emarginata*, Paragrass *Panicum barbinodes*, Kudzu *Pueraria lobata*, Solandra, Yew, Elephant Ear *Philodendron giganteum*, Black medic, Calophyllum, and Sanseveria as potential problem species.

Common Name	Species
Ardisia	*Ardisia acuminata*
Cow Cane (Giant Reed)	*Arundo donax*
Fern Asparagus	*Asparagus densiflorus*
Long Leaf Asparagus	*Asparagus officinalis*
Wedding Fern	*Asparagus setaceous*
Madagascar Buddleia	*Buddleia*
Casuarina (Horsetail Tree)	*Casuarina equisetifolia*
Lady of the Night	*Cestrum nocturnum*
Fiddlewood	*Citharexylum spinosum*
Clerodendrum	*Clerodendrum spp.*
Pothos Vine	*Epipremnum pinnatum cv.*
Surinam Cherry	*Eugenia uniflora*
Indian Laurel	*Ficus retusa (microcarpa)*
Jumbie Bean (Wild Mimosa)	*Leucaena leucocephala*
Chinese Fan Palm	*Livistonia chinensis*
Creeping Fern	*Phymatosorus scolopendra*
Water Hyacinth*	*Piaropus crassipes*
Allspice	*Pimenta dioica*
Guava	*Psidium guajava*
Water Fern*	*Salvinia rotundifolia*
Mother-in-Law's Tongue	*Sanseviera trifasciata*
Brazil Pepper	*Schinus terebithifolius*
Wedelia	*Wedelia trilobata*

diverse mix of aliens in which native trees persist largely thanks to protection and planting in gardens and nature reserves. A group of 11 invasive canopy plants headed by the ubiquitous Casuarina and Brazil Pepper is present in 9 (60%) or more of the 15 habitats, and is at least visually prevalent even in exposed coastal habitats. Understorey plants are severely invaded by Wedelia, Fern Asparagus, Fennel, Japanese Hawksbeard, Sow Thistle and Cane Grass. Furthermore, the frequency in the understorey of recruits of Brazil Pepper, Surinam Cherry, Allspice, Chinese Fan Palm and other invasive canopy species suggests that the replacement of native forests with alien species is an ongoing process.

Although there are no quantitative data on the fauna of these habitats, it is expected that habitat homogenisation brought about by the spread of so many invasive plants has affected the composition of associated biota including bacteria, fungi, and invertebrates.

The Regulatory Framework

Regulatory responsibilities for dealing with invasive alien species lie with several different government departments. The activities undertaken fall into three broad categories: those with legislative responsibilities, including licensing; those providing technical support and advice; and those undertaking protection, enforcement and control. No single department has exclusive responsibility for any of these activities.

Today, there are several legislative instruments for tackling invasive aliens. The 1972 Fisheries Act prohibits the importation of any fish. The 1930 Agricultural Act covers the control of plant diseases and pests through the 1970 Regulations; this Act also covers restrictions on animal importations. The 1975 Protection of Birds Act specifically excludes four bird species from protection; these are the Common crow, Starling, Kiskadee and House sparrow. There is a gaping hole in the legislation with respect to the importation of plant species which is currently being addressed.

1. Prevention of Introduction

With the recent restructuring of the Ministry of Environment, the Department of Environmental Protection has responsibility for conducting a risk assessment to determine which non-native animal species are permissible. Health certificates must be presented for all imported animals, and there is a quarantine facility for placing animals in the event of any problems. The front line enforcement of these regulations lies with the Bermuda Customs who liaise with the Department of Environmental Protection. In 2000, the Government Plant Protection Laboratory inspected 813 shipments of plant material containing a total of 850,000 plants - from bedding plants and bulbs to cacti, Christmas trees, fruit trees and orchids - in addition to 10,622 fruits and vegetables, 7,231 cases of citrus and 3,440 bags of seed potatoes. In 1999 the Laboratory made 108 interceptions of which mites, thrips, whiteflies, mealybugs, aphids, spiders and snails were the most frequent. Despite this effort, it is accepted that there are improvements that could be made in current preventative measures: e.g. shipping containers which have been stored on soil lots, arrive on Bermuda's docks without sterilization; imported plants are transported from

the airport to the Botanical Gardens before being inspected; cruise ships arrive and dock with potted plants on board; and plants and some animals, such as dormant triops shrimp, may be purchased through the internet and mailed through the postal system undetected.

2. Control and Eradication

Bermuda bears history to a number of eradication efforts, one of the earliest being the torching of St Georges Island in the 1600s in an effort to get rid of the plague of rats. Given that many alien species remain relatively dormant for at least some period of time before really establishing themselves, there is an opportunity for immediate action when an alien species is first identified. This has been demonstrated with such species as guinea pigs, when a prompt response to an illegal release into the wild has enabled their speedy capture. Responsibility for early detection typically falls on the Departments of Environmental Protection, Conservation Services and Parks. However members of the public also have a critical role to play. The recent reports of the Pacific Lionfish in local waters, have all been through public reporting. Whilst Island-wide eradication is a lofty goal, eradication of a pest species on 'ecological islands' has been applied in Bermuda with great success. The most obvious example is Nonsuch Island, which has been restored and now represents Bermuda's pre-settlement habitats. More typically though, complete eradication is not a realistic option, and at best, an invasive alien species can be controlled. Priority is generally given to areas of ecological significance, such as the Island's nature reserves and successful restoration efforts are underway in Paget Marsh and Walsingham.

3. Education and Public Awareness

Despite the impact of the cedar blight of the mid 1950s, the visual presence of known predators such as Red eared slider terrapins and feral cats, and the persistence of nuisance pigeons and chickens, not all policy-makers or members of the public share the view that invasive species negatively impact biodiversity. NGOs have an important role to play in raising awareness, as does the Department of Conservation Services. A number of publications have been written for the wider public audience highlighting the threat posed by invasive species, whilst local expositions such as the Annual Exhibition and the Eden Project and the biennial Environmental Youth Conference, have been used as a platform for further broadcasting this message. Pamphlets produced by the Department of Environmental Protection also highlight the dangers of illegally importing plants and animals. There is a recognized need for more extensive training of front line enforcement agencies.

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Poster: Eradicating New Zealand flax *Phormium tenax* at Tristan da Cunha

Peter Ryan, Sarah Sanders, James Glass & Simon Glass

Ryan, P., Sanders, S., Glass, J. & Glass, S. 2007. Eradicating New Zealand flax *Phormium tenax* at Tristan da Cunha. p 243 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Tristan da Cunha faces numerous problems with invasive alien species, chiefly on the main island of Tristan. The two outer islands, Inaccessible and Nightingale, are both free of introduced mammals and have only a few species of introduced plants. One of the most intrusive plant invaders is the New Zealand flax *Phormium tenax*, a large, long-lived species that has the potential to transform the vegetation over large parts of the islands, which could negatively impact on seabird nesting sites. Accordingly funds were sourced from the Overseas Territories Environment Programme (OTEP) to start an eradication programme for the species at both islands.

The initial clearing programme planned for 2003 had to be postponed due to lack of space on ships to Tristan, but in September 2004 a team of four led by Peter Ryan set off from Cape Town armed with 1000 m of rope and an arsenal of clearing equipment to tackle the plants growing on the 200-300 m high sea cliffs of Inaccessible Island. Boosted by two high-altitude experts from South Africa's highly successful Working for Water alien clearing programme, they were able to remove almost all existing plants, estimated at some 500 fully grown individuals and several thousand smaller plants. Later that year Peter returned to the island on a bird census and was able to remove the last few large plants.

In the same summer, a team from Tristan led by James Glass, head of Tristan's Natural Resources Department, tackled the hundred or so plants growing on and around the Ponds on Nightingale. This was no mean feat, as some of these plants had grown to house-size dimensions and required a concerted team effort to uproot.

Nightingale Island is visited regularly by personnel from Tristan's Natural Resources Department, and they will continue to check for seedlings or re-growth of plants there. Inaccessible Island is seldom visited, and with the majority of plants growing on near-vertical cliffs, it requires dedicated follow-up. We are currently hoping to revisit the island in 2007, three years after the initial clearing, to remove any new growth.

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Poster: Alien plant invades Montserrat

S. Barrios, M. Hamilton and C. Clubbe

Barrios, S., Hamilton, M. & Clubbe, C. 2007. Alien plant invades Montserrat. p 244 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

Casuarina equisetifolia is an alien invasive plant that is threatening Montserrat's native habitats. Originally from Australia and the Pacific Islands, it is a species that spreads rapidly by wind blown seeds.

How to recognize the invader:

- Prefers dry sandy soils, especially near the seashore
- Colonises fresh volcanic ash
- Is a tree to more than 100ft producing a dense shade
- Has fine green branches, often drooping (A)
- The fruit is a small nut that contains many winged seeds that are wind dispersed (B)

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