

Proceedings of the Regional Workshop on Invasive Alien Species and Terrestrial Ecosystem Rehabilitation in Western Indian Ocean Island States

Sharing Experience
Identifying Priorities
&
Defining Joint Action

Seychelles - Monday 13th to Friday 17th October 2003



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Indian Ocean Plant Specialist Group

Regional Workshop on Invasive Alien Species and Terrestrial Ecosystem Rehabilitation for Western Indian Ocean Island states – Sharing Experience, Identifying Priorities and Defining Joint Action

Workshop Proceedings

*Berjaya Mahé Beach Hotel, Seychelles
13-17th October 2003*

Organised by the Indian Ocean Commission Regional Environment Programme (7.ACP.RPR.068), funded by the European Commission.

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Editors Note:

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J.R. Mauremootoo
Vacoas, Mauritius
December 2003

Cover illustration: A few emergent trees remain in a Mauritian upland forest formation invaded by several species of woody weed, notably Goyave de Chine *Psidium cattleianum*, a major woody weed in all the small islands of the south-western Indian Ocean. © John Mauremootoo

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Summary of Workshop Proceedings

The workshop was a first opportunity to bring together experts from the small islands of the south-western Indian Ocean to consider the threats posed by plant invaders to the indigenous terrestrial biodiversity of the region (Annex 1). This volume summarises experiences shared, priorities identified and joint actions defined during the workshop.

From formal presentations and field visits, as well as formal and informal discussions, it was clear that numerous Invasive Alien Species (IAS) management activities are being undertaken in the region. In La Réunion efforts are well advanced towards implementing a risk assessment procedure for proposed new plant introductions (le Bourgeois *et al.*). Species-led IAS management work has been undertaken in La Réunion (le Bourgeois *et al.*, Brondeau & Hivert), Seychelles (Vielle) and Mauritius (Gopal). Area-led management has been undertaken in La Réunion (Triolo), Mauritius (Gopal), Rodrigues (Payendee) and Seychelles (Barreau, Kueffer), including some exemplary islet restoration efforts in Mauritius (Gopal, Mauremootoo) and Seychelles (Hill *et al.*). Little information exists on the efficacy of this restoration work although opportunistic monitoring has been undertaken in Mauritius (Florens) and is being attempted on a more systematic level in La Réunion through the INVABIO project (Lavergne *et al.*)

Sharing experience has been hampered by a lack of accessible information on the IAS situation in the region. This shortcoming is now being redressed by initiatives such as the current workshop and the FAO regional assessment of invasive woody species in the region (Kueffer and Vos). Efforts to summarise anecdotal information and grey literature are exemplified by the synthesis of weed control methods in undertaken by ONF in La Réunion (Brondeau & Hivert).

International initiatives such as the Global Invasive Species Programme (GISP), the Cooperative Islands Initiative (CII) and others (Boudjelas) can complement national and regional efforts in IAS management. The potential benefit of such initiatives has been increased by advances in communications technology, manifested by the increasing amount of valuable information on IAS now available on the web (Annexes 8 and 9).

Finding sufficient resources for IAS management is a challenge, notably in the IFR Comoros where basic needs are inevitably prioritised above biodiversity conservation (Mohamed & Ibrahim, Ali Abdou). Mainstreaming, exemplified by the South African Working for Water scheme (Mauremootoo), offers hope that IAS management can be integrated into national developmental priorities. The proposed declaration on IAS to the forthcoming SIDS summit in Mauritius (Annex 7), as requested by the Seychelles Minister of the Environment in his opening address, represents a tangible effort of the workshop participants to mainstream IAS issues.

Many of the IAS management priorities identified by workshop participants (Annex 2 and 3) could benefit from a regional approach. The perceived need to maintain the momentum generated by the workshop (Annex 4) resulted in the articulation of measures that could be pursued to advance IAS management efforts in the region in the short, medium and long terms (Annex 5). A key component of this will be a formalised regional programme for IAS management (Annex 6). Such a programme will take some time to develop. In the meantime it seems likely that the informal network of workshop participants (Annex 10) can help to advance IAS issues to the top of the regional agenda.

Allocution de M. Didier Slachmuylders, Commission de l'Océan Indien

Excellence Monsieur le Ministre de l'Environnement, Mesdames et Messieurs représentants des Ministères des Affaires Etrangères, de l'Environnement et de l'Agriculture, Chers collègues des Iles de l'Océan Indien,

C'est un grand plaisir pour nous, techniciens et scientifiques des pays membres de la COI de pouvoir se retrouver dans le cadre enchanteur des Seychelles pour cet atelier régional sur la problématique des espèces exotiques envahissantes et de la réhabilitation de sites d'intérêt écologique.

Je tiens tout d'abord à remercier nos partenaires seychellois, plus particulièrement le Ministère de l'Environnement et le Ministère des Affaires Etrangères, pour leur assistance précieuse dans l'organisation de cet atelier.

Je me dois également de remercier l'Union européenne qui a autorisé le financement de l'atelier sur les ressources du Programme Régional Environnement, dont il représente la dernière manifestation puisque ce projet et son financement seront définitivement clôturés au 31 décembre.

Nos collègues réunionnais sont venus nombreux, et en qualité, ce qui montre tout l'intérêt porté par les pays à la thématique de l'atelier. Je remercie les différentes instances et départements techniques qui ont permis leur prise en charge et leur participation : l'ONF, le CIRAD, le Conseil Régional ...

Pour encadrer et animer l'atelier nous avons fait appel à IUCN (Union Internationale pour la Conservation de la Nature), plus particulièrement à son groupe spécialisé en plantes qui est représenté par Dr. John Mauremootoo, du IUCN Indian Ocean Plant Specialist Group et par Dr. Souad Boudjelas qui a fait spécialement le déplacement depuis AUCKLAND, New Zealand.

Un long voyage ! Mais nous espérons qu'elle va nous apprendre beaucoup de choses intéressantes et utiles sur l'expérience de IUCN dans les îles du Pacifique qui sont confrontées aux mêmes problématiques de plantes envahissantes que les îles de l'Océan Indien.

Expérience intéressante par son aspect régional.

Ce sera en effet un des thèmes de réflexion de cet atelier de voir quelle est la pertinence et la plus value d'une approche régionale pour répondre à ces problèmes et de voir comment, le cas échéant, la structurer.

Un des objectifs de l'atelier est aussi de faire partager à nos amis comoriens l'expérience de deux autres pays ACP de la région, Maurice et Seychelles, en matière de lutte contre les espèces envahissantes et en matière de conservation et de restauration, en montrant

l'efficacité d'une approche qui associe les services techniques – environnement, forêts – et des ONG qui ont atteint une reconnaissance internationale par leur savoir-faire, je pense – mais de façon non exclusive – à Mauritius Wildlife Foundation et à Nature Seychelles.

Qu'attend-on de cet atelier ?

Les résultats sont à deux niveaux :

- de consolider les échanges entre les scientifiques et les techniciens de nos pays, afin que se crée – même de façon informelle dans un premier temps – un réseau régional de compétences
- d'arriver à formuler un certain nombre de recommandations concrètes que nous soumettrons à la COI pour qu'elles soient prises en considération et intégrées dans la préparation des nouveaux projets régionaux actuellement à l'instruction.

Une originalité de cet atelier est de rassembler des praticiens d'horizons différents et parfois antinomiques puisque nous avons parmi nous des botanistes, des « conservationists » mais aussi des agronomes et des forestiers. Et nous aurons également l'occasion de voir les aspects économiques des actions de lutte contre les envahissantes et de la restauration.

Je suis convaincu que cet atelier sera fructueux et qu'il pourra déboucher, à terme car les procédures d'instruction des projets sont souvent longues, sur des réalisations concrètes.

Au nom de Monsieur le Secrétaire Général de la COI, je remercie les Seychelles pour leur accueil.

Regional Workshop on Invasive Alien Plant Species and the Restoration of Terrestrial Ecosystems in the South-West Indian Ocean Islands

Opening Speech by the Seychelles Minister for Environment Mr Ronny Jumeau

Ladies and Gentlemen:

Some 45 million years ago, during the break-up of the great continental landmass of Gondwana, Seychelles broke away from, and was left behind by the Indian plate as it moved north-east to eventually form today's Indian sub-continent.

By the time the first settlers landed here a mere 230 years ago, they found unique forest ecosystems that had evolved over millennia rising from a pristine coast to our highest peak of Morne Seychellois.

It then took our forefathers less than 150 years to almost entirely wipe out our unique flora. By the end of the 19th Century, the natural vegetation remained only on the most treacherous slopes and on lands that could not be cultivated.

Thanks to the introduction of strict environmental laws and sustainable practices, much of our vegetation has clawed its way back today, but our islands still bear the heavy scars of our previous deforestation.

The greatest menace to our native plants today are Invasive Alien Species, sometimes deliberately introduced with good intentions, as in the case of the cinnamon for commercial and economic reasons and the albizia to combat erosion.

However, once here, these introduced species have simply taken over in a biological colonisation that has pushed endemic plants out of their native habitats, and in some cases to the brink of extinction. These exotics continue to flourish unabated today, to the extent that they now threaten to wipe out the hard-won gains we have made against deforestation.

Nowhere is this more visually alarming than in the smothering and at times menacing presence of invasive creepers wherever you care to look. Such is the speed and aggressiveness with which these creepers spread, and their insidious impact on our native plants, that many of us have all but forgotten that the cinnamon, albizia, and other species such as clidemia and guava, to name but some, are just as alien, more widespread and have been around almost as long as we can remember.

But not all these plant pests were introduced by well-meaning authorities of the past. Some are ornamental plants smuggled in by home gardeners and other individuals

seeking exotic species abroad so as to win a competition, embellish a grand occasion, or just to boast they have something their next door neighbour does not have.

So please do not make a scene at the airport, or make angry phone calls to high placed friends or relatives, when the plants you have tried to smuggle in illegally without the required permits are seized by the authorities. That very exotic you thoughtlessly smuggle in today for your own vanity or private gain, may tomorrow, through its uncontrolled propagation or through a disease it may carry, become a scourge for the whole country.

Our fellow participants from Comoros, Mauritius and Reunion – which though geologically different from Seychelles share a similar biogeographical history – know only too well that all the islands of the region have suffered the same historic fate, encounter the same problems today, and face, to varying degrees, the same current threats.

Indeed, on a global scale, invasive plant and animal species in general are considered to be the second greatest threat to biodiversity after habitat loss. Some ecologists predict that biological pollution by alien invaders may surpass loss of habitat to become the leading factor in ecological disintegration.

Fewer and fewer people scoff at such a possibility when they realise that the explosion in global trade and travel if not properly controlled to stop the mostly unintentional spread of Invasive Alien Species by road, rail, ship and air, could be a recipe for a biological disaster.

As if this is not frightening enough, the IUCN or World Conservation Union, which is represented at this workshop, has assessed that the threat of Invasive Alien Species is especially acute on islands in general, and for small island countries in particular.

And yet, the islands of this region are still characterised by a relatively high biodiversity and endemism. They are, indeed, a priority area for international conservation as Madagascar and the other Western Indian Ocean islands have been identified as the most biodiversity rich area in Africa and the sixth richest in the world.

On the other hand, the very same reduced landmasses and long physical isolation over millions of years that favoured the evolution of the unique species and ecosystems that make us so special have also made islands overly fragile to environmental changes and particularly vulnerable to invasion by exotic plants.

The answer, then, is to turn this very isolation into an advantage by improving our capability to prevent the arrival of alien species through better science and knowledge, wiser policies, more effective laws, improved management and more efficient surveillance, monitoring and enforcement.

Honourable Minister Mr. Ronny Jumeau Workshop Opening Speech

Easily said... but another common characteristic of small oceanic islands is that we are generally woefully limited in terms of both funding and capacity. This makes it so much more difficult a challenge for us to keep out, defend against, control and push back these alien invaders.

But do this we must, before the damage becomes irreversible. In the islands of New Zealand, for example, 47 per cent of all plants are introduced species.

This is why we have come together under the Indian Ocean Commission's Regional Environment Programme to pool our knowledge, resources and experiences in a combined fight against invasive plant species.

The workshop will allow us to establish a regional Invasive Alien Species network linking resource persons, institutions and conservation bodies within the IOC region and identify priorities for restoring our ecosystems within South-West Indian Ocean islands that could be implemented at a regional level.

I wish you all a very fruitful workshop on the way to finding creative solutions to save our unique regional environment. May I suggest that your deliberations eventually culminate in a resolution on the threat of Invasive Alien Species to small island states for the Barbados + 10 meeting in Mauritius next year.

Let us not miss that opportunity to bring this particular problem of ours to world attention.

I thank you all

The Work of the IUCN in Invasive Species Management

John Mauremootoo¹ & Souad Boudjelas²

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Abstract

This presentation sets the scene for the workshop to come. The initial section deals with the following topics: The overall goals of the workshop; the issue of Invasive Alien Species (IAS), with an emphasis on consequences of IAS for biodiversity on islands; and the scope for management of IAS including an introduction to approaches developed globally and in other regions. There then follows a review of the work of the IUCN with a particular emphasis on the Species Survival Commission (SSC) and the specialist groups within the SSC. The Indian Ocean Plant Specialist Group (IOPSG), responsible for the scientific organisation of this workshop, is introduced. Finally the work of a particularly dynamic specialist group, the Invasive Species Specialist Group (ISSG) is reviewed.

The Scope of the Workshop

The expected outcomes of the forthcoming workshop are very clearly stated in the workshop title. These expected outcomes comprise three elements:

Sharing experience

The islands and island groups represented in this workshop all have some experience of the effects of Invasive Alien Species on their native terrestrial biodiversity. They also have some experience in managing the effects of IAS. By sharing experiences we can help ensure that best practices are adopted in the region and that mistakes made somewhere at some time are not repeated. All island groupings represented have small populations in global terms and resources are, and always will be, limited. Therefore, the complete range of expertise needed to manage IAS will never be found within a single island or island group. Meeting and sharing experiences with experts from other parts of the region will help practitioners to access the expertise that does exist within the region. In addition experts within the region are often part of a wider global network (much of it informal) through which information can be exchanged. The sharing of experience in the region, therefore, can open the much wider door of global information exchange.

Identifying priorities

To understand what we have in common and what things are specific at the island or island group scale we must consider priorities. This will help us to identify areas, which

are amenable to treatment at the regional scale and those areas, which are best managed at a more local scale.

Defining joint action

Having identified priorities and those that can be enhanced by a regional approach it is necessary to translate these priorities into regional action that will have a positive impact on biodiversity. By the time this workshop is completed it is hoped that the participants will have arrived at a preliminary sketch of a regional project for the improved management of IAS in Indian Ocean Commission member states. This can then be elaborated into a full project proposal that could be presented to donors for possible inclusion in the environment programme currently being formulated under the 9th EDF or GEF, FFEM, etc.

The issue of Invasive Alien Species

The phrase “The Great Reshuffling” was coined by Jeffrey McNeely, Chief Scientist of the IUCN (World Conservation Union), and used as a title of a book that discusses the human dimension of IAS (McNeely 2001). The phrase refers to the breaking down of ecological barriers that have facilitated the evolution of distinctive species and ecosystems in different parts of the world. The inadvertent ending of millions of years of biological isolation through the mass movement of goods and people has been likened to the reformation of Pangaea, the single global supercontinent that broke up in at the end of the Permian period 248 million years ago.

Geographically or evolutionarily isolated ecosystems are particularly vulnerable to invasion. These systems are often characterised by features that are correlated with susceptibility to the impacts of IAS such as a high degree of endemism, relictualism whereby species groups that are no longer found on larger areas remain in isolated systems and disharmony whereby certain widespread species groups are not found in isolated systems (Whittaker 1998). Oceanic islands are classic examples of such systems but other systems, such as lakes and mountain tops, that behave as “ecological islands” can be found on continents.

Multi-island states, as found in the Western Indian Ocean, can be extremely vulnerable to IAS transfers from one island to another. Once a species arrives in one of the islands frequent inter-island movement together with the usual lack of inter-island quarantine means that other frequented islands in the group are very vulnerable to colonisation. Rats, which have affected virtually all islands and island groups are classic examples of hitchhiker species that have rapidly colonised island groups once established on an individual island (Atkinson 1985).

Though islands are vulnerable to the effects of IAS they are not uniquely vulnerable (Simberloff 1995). Virtually all areas in the world are significantly affected by IAS (Parker *et al.* 1999). The current rate of habitat fragmentation means that mainland systems are becoming increasingly insular and the distinction between mainland areas and islands is becoming blurred. In some ways islands are at an advantage when it comes to managing IAS. In principle, their insularity makes it easier to keep things out.

Depending on resources and island size it is also possible to eradicate certain species, notably mammals, from islands (Veitch 2001, Brown and Sherley 2002, Thomas and Taylor 2002). Unfortunately for most plant species eradication is rarely an option once the species is established on anywhere but the smallest of islands (Mack and Lonsdale 2002) although control to minimise impact is often feasible.

IAS cover all taxonomic groups and while this workshop, which has been convened under the auspices of the IUCN Indian Ocean Plant Specialist Group (IOPSG), is mainly addressing invasive plants (often the most visible invasive group) it must be remembered that ecosystem degradation does not know taxonomic boundaries. Introduced animal pests and diseases have serious ecological impacts, which are very difficult to predict.

What can we do – a pathways approach to IAS management?

It is clear that the impacts of IAS are increasing but this does not mean a global homogenisation of biodiversity is inevitable. There is a great deal we can do to manage the effects of IAS.

One key question that needs to be asked right at the beginning of any IAS management programme is “what are we managing for?” (Zaveleta *et al.* 2002). The management of IAS is a means to an end not an end in itself. The desired outcome must be clearly stated and if the proposed management action does not help to increase the probability of reaching the desired outcome then the desirability of the management action must be questioned.

For effective management of IAS it is important to understand the specific approaches that are needed for individual species. However, detailed plans cannot be produced for every single current and potential invasive species; there are simply too many of them. Therefore, there is an urgent imperative to adopt approaches to the management of invasive species as a whole. Individual species management measures can then be subsumed under generic approaches.

The now widely accepted generic management approaches for IAS is that of “pathways management” (e.g. McGregor *et al.* 1998). Under this approach IAS management is considered from a point before a potentially invasive species arrives – “pre-border” to the moment a potentially invasive species arrives – “border” and from the moment a potentially invasive species establishes itself in the recipient area – “post-border”. The maxim “prevention is better than cure” strongly applies to IAS so the more potentially invasive species whose entry is prevented at the pre-border and border stages the fewer species will need to be subject to expensive and difficult management work at the post-border stage.

There are now many excellent publications relating to the pathways approach to IAS management. An ideal first book to read in this field is the Wittenburg and Cock (2001) *Invasive Alien Species: Toolkit of Best Prevention and Management Practices* produced under the Global Invasive Species Programme (GISP).

The Global Strategy on Invasive Alien Species

GISP has produced several very valuable documents on IAS management. In addition to *The Toolkit* and others summarised in Annex 8 of these proceedings is *The Global Strategy on Invasive Alien Species* (McNeely *et al.* 2001). This short document introduces the IAS issue in a non-technical way. This introduction is followed by a review of management and policy responses to the problem of IAS. The final chapter outlines the following ten strategic responses to address the problem of IAS:

1. Build management capacity.
2. Build research capacity.
3. Promote sharing of information.
4. Develop economic policies and tools.
5. Strengthen national, regional, and international legal and institutional frameworks.
6. Institute a system of environmental risk analysis.
7. Build public awareness and engagement.
8. Prepare national strategies and plans.
9. Build IAS issues into global change initiatives.
10. Promote international cooperation to deal with the problem

Without such strategic responses, the management of IAS is always likely to be inadequate. It is to be hoped that the current workshop will help us address strategic needs at the regional level as has been done in the Pacific with the South Pacific Regional Environment Programme (SPREP) and the IUCN/ISSG Cooperative Islands Initiative (Boudjelas this volume).

The Work of the IUCN SSC groups

The IUCN was founded in 1943. It is now one of the world's major conservation NGOs. The mission of the IUCN is "To influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and sustainable."

The IUCN's main headquarters are in Gland Switzerland and it has a series of regional offices throughout the world. The main regional offices of relevance to the islands of the Western Indian Ocean are East Africa Regional Office based in Nairobi and the Regional Office for Southern Africa based in Harare.

The strength of the IUCN lies in the vast network of experts that work under its umbrella for the common goal of biodiversity conservation. The organisation brings together over 10,000 scientists and experts from 131 countries. The vast majority of these people give their time freely as volunteers.

The IUCN Species Survival Commission

This concept was first launched by IUCN 50 years ago with the creation of the Survival Service Commission (SSC), renamed the Species Survival Commission (SSC) in 1981. The Commission's work and achievements have had worldwide impact in the past. Now

that the spotlight is firmly on the growing global biodiversity crisis, the work of SSC is more relevant than ever.

The SSC is the single greatest source of species conservation information in the world. The SSC network provides fundamental understanding of species, their biology, and the role they play in ecosystems. Through the study of plants and animals, it detects trends, identifies threats, and provides a scientific basis to determine the best conservation and sustainable development strategies from at all levels from the global to the local. The SSC then promotes these strategies to the individuals, communities, conservation organisations, and governments who can implement them.

The SSC Chair is elected by IUCN members at the Union's World Conservation Congress, which is held every three to four years. The Chair directs the Commission and serve as an IUCN Councillor. Members of the SSC are invited through the Chair.

A steering committee, which represents a balance of regional and thematic perspectives, provides overall direction to the work of the Commission. A smaller sub-group, the Executive Committee, provides routine management of SSC. There are two other committees, the Plant Conservation Committee, which gives direction and guidance to the SSC's plant-related conservation activities, and the Red List Committee, which guides the development of the Red List Programme.

The IUCN species programme coordinates the implementation of SSC's work and acts as the secretariat to the Commission. The programme head, deputy head, flora, fauna and communications staff are based at IUCN headquarters in Gland, Switzerland while the Red List, Freshwater, and Wildlife Trade Programme staff are based at the SSC office in Cambridge, UK.

Bird, mammal, plant, invertebrate, amphibian, fish, and reptile experts, government officials, wildlife veterinarians, marine biologists, and managers of zoos or botanical gardens are among the many who form the global SSC network.

An SSC member may be the world authority on a single plant or animal species or a lawyer willing to help develop wildlife legislation. Another might be the head of a government agency charged with managing the natural resources of a village, region, or country.

Every conservation problem is unique and requires a different approach or combination of tactics. The diversity of talents and expertise within the SSC membership enables the Commission to respond to the many challenges facing the conservation community.

The Specialist Groups

SSC members work within smaller networks called Specialist Groups which focus on concerns relating to the conservation of a species or group of species, on a disciplinary area such as veterinary health, or reintroduction of species (into previously occupied areas), or concerning a region such as the Southern African Plant Specialist Group or Indian Ocean Plant Specialist Group. The Specialist Groups covering species from

elephants to orchids, crocodiles to medicinal plants, initiate and, in many cases, implement a range of conservation projects in the field, convene workshops, raise funds, carry out research, and publish action plans. They provide scientific advice to conservation organisations, government agencies, and IUCN members, and support implementation of international conservation treaties.

The specialist groups are small enough to initiate rapid action but are part of a larger network. This facilitates action at the ground level being communicated up to the regional and world level. This helps translation of action into global conservation policies. Similarly being part of the IUCN network means that those working on the ground can be kept abreast of global developments. This provides a framework and context within which local action can be taken. Framing one's actions within a global context can also be the key to persuading key stakeholders of the significance of the local action.

Communicating the work of the SSC

SSC has a number of vehicles through which it communicates its important and broad-ranging work to various audiences. The main channel is the website which contains a wealth of information on all aspects of the Commission's work, including lists of all publications, contact details for Specialist Groups, and news releases ([HTTP://WWW.IUCN.ORG/THEMES/SSC/](http://www.iucn.org/themes/ssc/)).

Species, the SSC's biannual newsletter, informs SSC members about conservation efforts taking place throughout the network. It includes reports from Specialist Groups, feature articles, and Programme updates. A monthly electronic bulletin, *The SSC E-Bulletin*, acts as a supplement to *Species* and helps to keep staff, the IUCN network and partner organisations up to date with news and announcements from the Commission. The Bulletin is also available on the SSC website.

A growing number of SSC Specialist Groups are developing websites and many have mailing lists and UserGroups that help keep their widely dispersed membership in touch with issues and events relating to their species or area of interest

The Indian Ocean Plant Specialist Group (IOPSG)

The IOPSG has been in existence since September 1994. Its Co-Chairs have been Dominique Strasberg (La Réunion) & Eshan Dulloo (Mauritius). Until the current workshop (organised under the auspices of the IOPSG) the group has been fairly dormant. It currently has 25 members who are active in the field of plant conservation in the Indian Ocean region.

There have, however, been some activities launched under the auspices of the IOPSG. Species recovery plans have been written for three Critically Endangered Mascarene plants (Couch and Mauremootoo 2003a, b and c and Couch *et al.* 2003) and are now being executed. In addition, of course, individual IOPSG members have been highly active in plant conservation activities in the Mascarenes as part of their regular activities.

The current workshop represents an ideal opportunity to reinvigorate the IOPSG. Given its fairly dormant nature up to now it could be argued that it would be a better course of action to initiate a new group instead of relaunching the IOPSG. A new group can indeed

be launched and it can be complementary to the IOPSG. However, the IOPSG has the considerable advantages of having already been established and being part of the SSC network.

It is to be hoped that the years to come will see a much more active IOPSG that can be as dynamic regionally as a group like the Invasive Species Specialist Group (ISSG) is globally. The work of the ISSG is discussed below.

IUCN and Invasive Alien Species

Invasive Alien Species are one of the priority concerns of the IUCN because of the damaging impacts they are having on biodiversity and livelihoods globally. This concern is reflected in the wide variety of activities undertaken by the IUCN; ranging from the technical work of the SSC to the policy work of the Biodiversity Programme and Law Centre and to field activities in East Africa and elsewhere. The IUCN is actively engaged in providing technical support and policy advice on IAS to several international forums, such as the Convention on Biological Diversity, RAMSAR and to other conservation and regulatory organisations.

Efforts are being made within the IUCN to mainstream IAS issues in different parts of its programme. Plans are underway to create a position at IUCN HQ in Gland, Switzerland for an IAS Senior Adviser whose role will be to coordinate IAS activities across the organisation and to ensure their integration with the other parts of IUCN's programme.

IUCN publishes a variety of material including books, technical papers, reports and awareness material (see Annex 8).

IUCN Eastern Africa Regional Programme

IUCN regional networks play a significant role in raising awareness of IAS issues, such as their impacts on biodiversity, their economic implications, and options for management, at all levels. Of relevance to this workshop is the work of the Eastern Africa Regional Programme. Following are some of the activities/projects this programme is involved in:

- The GEF-funded project on “Removing barriers to Invasive Plant Management in Africa”. The purpose of this project is to remove the barriers to effective prevention and management of IAS in four pilot countries: Ethiopia, Ghana, Uganda and Zambia. The focus is on invasive plants in both terrestrial and aquatic ecosystems. The major partner in the implementation of this project will be CAB International (CABI) through its Africa Regional Centre based in Nairobi.
- Working with The World Agroforestry Centre (ICRAF) and The World Fish Centre (ICLARM) on reducing IAS escapes from agroforestry and aquaculture. IAS introduced into containment for agroforestry and aquaculture purposes may escape and become invasive (Wittenberg and Cock, 2001). Therefore, it is imperative to include these sectors in finding and implementing solutions.
- Assisting with the development and implementation of IAS activities of the New Partnership for Africa's Development (NEPAD).

IUCN and the Global Invasive Species Programme

IUCN is one of three founders of GISP in 1997. The other two founders are the Scientific Committee on Problems of the Environment (SCOPE) and CABI. As part of the Executive Board, the IUCN helps define strategy for the programme. They also provide support to its Working Groups and to several activities of the programme including: development of awareness and understanding of IAS issues at regional level across the world; promoting cooperation between countries on the management of IAS and contributing to several important GISP publications on IAS (see Annex 8).

IUCN and marine invasive species

Alien species including pathogens carried in ship's ballast water are having devastating impacts on aquatic species and ecosystems throughout the globe. To address these impacts the Maritime Organisation (IMO) in partnership with GEF and UNDP in 2000 launched the Global Ballast Water Management Programme (GloBallast). This programme is assisting developing countries to reduce the transfer of harmful aquatic organisms and pathogens in ships' ballast water, to implement the IMO Ballast Water Guidelines and to prepare for the new IMO Ballast Water Convention.

The Global Marine Programme of the IUCN and its nodes in the Mediterranean and Eastern Africa are involved in aquatic IAS issues and are forging cooperation with GloBallast to develop understanding and management procedures for marine invasive species. IUCN is also involved in surveys of marine invasive species in tropical waters, in work on the potential of invasive species hybridizing with native species in coastal waters and in the impact and management of IS in Marine Protected Areas in several of regions around the world.

IUCN Invasive Species Specialist Group (ISSG)

The ISSG is a network of expert volunteers, organised under the auspices of the SSC and dedicated to invasive species and their management. The ISSG's mission is:

... to reduce threats to natural ecosystems and the native species they contain by increasing awareness of invasive alien species, and of ways to prevent, control or eradicate them.

The ISSG has an active and growing core staff at its Auckland HQ who bring together extensive global experience and skills in all areas of invasive species including: prevention and management of invasive species; ecology of invasive species; policy; training; information management and dissemination; and facilitation and co-ordination of projects. The core staff are supported by grants from a variety of sources and are involved in diverse activities.

A global network of over 150 invasive species specialists distributed across 42 countries complements the core personnel. This network constitutes a comprehensive knowledge base that ISSG calls upon to provide in-depth expert input.

The ISSG provides assistance to the IUCN with its work on IAS in international forums (e.g. Convention on Biological Diversity, RAMSAR, IMO, WTO), provides technical and scientific advice to IUCN Members and the community at large (e.g. government or regional agencies) on developing strategies or legislation and on risk assessments prior to

introductions, as well as on facilitating awareness raising and community involvement. The overall aim is to encourage mainstreaming IAS issues and to encourage IAS to be addressed in an ecosystem context.

In addition to providing assistance to IUCN with its work on IAS in international forums, ISSG, also provide technical and scientific support to IUCN members and the community at large (e.g. governments, NGOs and regional conservation agencies) on developing policies, strategies, legislation and management responses, as well as on facilitating and promoting awareness raising and community involvement. The overall aim is to encourage mainstreaming of IAS issues and to encourage IAS to be addressed in an ecosystem context.

Other ISSG activities include:

- **Hosting and coordination of the Cooperative Initiative on Invasive Alien Species on Islands:** (Boudjelas this volume)
- **Development and management of the Global Invasive Species Database:** this database was developed under the aegis the global initiative on IAS led by GISP. It provides information on IAS to agencies, resource managers, decision-makers, and interested individuals. It focuses on invasive species that threaten biodiversity and covers all taxonomic groups from micro-organisms to animals and plants. Species information is supplied or reviewed by expert contributors from around the world and includes: biology, ecology, distribution, management information, references, contacts, links, and images (www.issg.org/database)
- **Publication of *Aliens* newsletter:** published bi-annually, *Aliens* provides interesting and timely information on IAS and associated issues. It focuses on conservation issues rather than economic, health or agricultural aspects of alien invasions
- **Management of Aliens-L listserver:** Alien-L is dedicated to invasive alien species that threaten biodiversity. It allows users to freely seek and share information on IAS and related issues. Participation from all who are interested in the IAS problem is welcome (www.issg.org/newsletter.html#Listserver)
- **Preparation and publication of IUCN Guidelines for the Prevention of Biodiversity Loss caused by Alien Invasive Species** (adopted in 2000): (www.iucn.org/themes/ssc/pubs/policy/invasivesEng.htm)
- **Other Publications:**
 - Proceedings of the International Conference on Eradication of Island Invasives: Veitch C. R. and M. N. Clout (eds.) 2002. *Turning the tide: the eradication of invasive species*. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.
 - Sarah Lowe, Michael Browne, Souad Boudjelas and Maj De Poorter (2000). *100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database*. A booklet published for the purpose of raising awareness of the IAS problem. www.issg.org/booklet.pdf

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Woody Invasive Species: A Regional Assessment

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Abstract

This article presents the results of a survey on the status of invasive woody plant species in the western Indian Ocean funded by the Food and Agriculture Organization of the United Nations (FAO) and undertaken jointly by the Ministry of Environment of Seychelles and the Geobotanical Institute of ETH Zurich.

The survey compiles the available knowledge on the biology and management of woody invasive species in the region.

It gives a compilation of the regional invasive woody flora and compares its general characteristics to those of the invasive flora of worldwide tropics. It discusses the degree of invasion and the resistance to invasion per habitat as well as the major environmental and economic impacts of invasive plant species. It presents past and present management measures per country mainly regarding prevention, control of invasive species, habitat restoration, and the development of a social and institutional framework to fight invasive species.

Introduction

Within the framework of biosecurity and forestry (Cock 2003) the Forestry Department of the Food and Agriculture Organization of the United Nations (FAO) set up a program to investigate the invasiveness of forest trees. A global review identified considerable knowledge gaps in understudied regions (Haysom and Murphy 2003). A set of regional case studies should help to fill these gaps. The first of such regional case studies to be published was that for Southern Africa (Nyoka 2003). The report on woody invasive species in the Western Indian Ocean (Kueffer *et al.* 2003) summarised in this paper is the second such survey.

The study comprised the small island states of the Western Indian Ocean, i.e. Mauritius and Rodrigues, La Réunion, Seychelles, and Mayotte and IFR Comoros (Comoros Archipelago). Its objectives were threefold:

- Compilation of available published, unpublished and anecdotal knowledge on the biology and management of woody invasive species in the region
- Development of a rapid assessment method for regional surveys on invasive species
- Initiation of a national and regional network of stakeholders and experts

For each country a written standardized questionnaire was sent to all participants about one month before the experts were visited in the respective countries for face-to-face interviews. In the Seychelles, additionally a national stakeholder workshop was organized. 10-35 experts from ministries (agriculture, environment), NGOs and the private sector participated per country. The structure of this summary follows the structure of the report.

In the first part, a general overview of conservation issues and especially the past disturbance history is given. The main invasive species are compiled. The general characteristics of the invasive woody flora are compared to other tropical regions. The degree of invasion is given per habitat and the resistance of habitat types to invasions as well as the major environmental and economic impacts of invasive plant species are discussed.

In the second part, past and present management measures taken in the different countries are presented. For the purpose of this conference, we point out present benchmarking examples and future management priorities for i) prevention (awareness building, border control & quarantine, legislation, containment within countries and screening systems), ii) mechanical, chemical and biological control, iii) habitat restoration and iv) the social and institutional framework (networks, interagency planning and databases, co-financing and mainstreaming, and conflicts of interest).

Special features of the report, only partly covered in this summary, are species-specific fact-sheets (*Cinnamomum verum*, *Ligustrum robustum* subsp. *walkeri*, *Litsea glutinosa*, *Rubus alceifolius*) and text boxes where up-to-date information is given on specific issues by specialists (table 1).

Title of text box	Authors
Research projects of the University of Mauritius	Vincent Florens, University of Mauritius
Invasive plant species control methods – experiences of the Office National des Forêts of La Réunion (ONF-Réunion)	Jean Hivert, ONF-Réunion
The INVABIO research project in La Réunion	Christophe Lavergne, Conservatoire Botanique National de Mascarin (CBNM)
Potentially invasive species in La Réunion	Christophe Lavergne, CBNM
Invasive exotic plant species on small granitic islands	Michael Hill, Nature Seychelles
The impact of invasive plants on native insects in Seychelles	Pat Matyot, Island Conservation Society (ICS)
Synopsis of the interrelationship between native birds and alien vegetation	James Millett, Rachel Bristol, and Nirmal Jivan Shah, Nature Seychelles
Habitat restoration in the Morne Seychellois National Park	Frauke Dogley, Plant Conservation Action Group

Table 1. Overview of the text boxes included in the report that give detailed up-to-date information on specific issues by specialists.

In this study an invasive species is defined as an exotic species, with a ‘fast’ spreading rate, and a negative environmental or economic impact.

Part 1: Main invasive species, invasiveness and impacts

Study area

Two of the studied island groups are equatorial (Seychelles, Mayotte and IRF Comoros), two are sub-tropical (Mauritius and Rodrigues, La Réunion). All except the granitic islands of the Seychelles are of volcanic origin. The land mass ranges from 438 km² (115 islands of Seychelles) to 2,500 km² (La Réunion). With the exception of the Comoros archipelago the studied areas are very isolated (>1,500 km from nearest mainland). Between c. 0-5% (Mauritius, Rodrigues, Seychelles) to c. 20-30% (IFR Comoros, La Réunion) of relatively undisturbed native vegetation remain.

While the IFR Comoros still lives mainly on a subsistence agriculture economy, the others have transformed their economies during the last few decades into service-oriented economies with an important tourist industry. This transformation stopped deforestation and made nature protection a national priority.

The studied region is a priority area for international conservation because of its high endemism (WIO biodiversity hotspot, Global 200 Ecoregion, Centre of Plant Diversity (WWF, IUCN)). Introduction of invasive species that followed the colonial development can be broadly categorized into four phases (not applicable to Comoros Archipelago):

- Phase 1: Before 1760, First settlements. Limited impact, introduction of alien animals.
- Phase 2: 1760-1830, Permanent settlements. Main introductions of alien plant species, destruction of lowland habitats.
- Phase 3: 1830-1960s, Fast population & economic growth. Main habitat destruction
- Phase 4: After 1960s, Post-colonial phase. Mainly accidental introductions, and propagation of exotic ornamentals

Main invasive species

The invasive species compiled in the report were categorized into three groups:

i) main invasives, ii) non-consensus species, and iii) potentially new invasives. Main invasive species were mentioned by most of the experts consulted and in the literature. Non-consensus species were rated as invasive only by a sub-set of the experts consulted and literature. Potentially invasive species show a tendency to naturalize in the country and proved to be invasive in other countries of the tropics. The main invasive species were further rated as either a.) most problematic or b.) problematic. The species that are most problematic in at least one country of the region are compiled in table 2.

Species	Comoros Arch.	La Réunion	Mauritius	Seychelles	Tropics
<i>Acacia mangium</i>	**			(*)	
<i>Acacia auriculiformis</i>	**	(*)			3
<i>Alstonia macrophylla</i>				**	
<i>Ardisia crenata</i>		*	**	*	1
<i>Casuarina equisetifolia</i>	(*)	**	(*)	**	3
<i>Cinnamomum verum</i>	*	(*)	(*)	**	2
<i>Clidemia hirta</i>	**	**	*	*	3
<i>Hiptage benghalensis</i>		**	**		2
<i>Lantana camara</i>	**	**	**	*	3
<i>Ligustrum robustum</i>		**	**		3
<i>Litsea glutinosa</i>	**	*	(*)	(*)	3
<i>Paraserianthes falcataria</i>				**	2
<i>Psidium cattleianum</i>	**	**	**	**	3
<i>Ravenala madagascariensis</i>		(*)	**	(*)	3
<i>Rubus alceifolius</i>	(*)	**	**		3
<i>Schinus terebinthifolius</i>		*	**		3
<i>Solanum mauritianum</i>	(*)	**	(*)		3
<i>Spathodea campanulata</i>	**	(*)	(*)	(*)	2
<i>Syzigium jambos</i>	**	**	**	**	2
<i>Ulex europeaus</i>		**	(*)		3

Table 2. The woody invasive species that are very problematic in at least one country of the Western Indian Ocean region. (*): potentially invasive or non-consensus, *: main invasive, **: most problematic invasive. 1: potentially invasive; 2: moderately invasive; 3: highly invasive according to Binggeli *et al.* (1998).

Our compilation of the most problematic invasive species of the region should be used with caution. It is based on the contingent valuation of a few experts. However, it shows the extensive overlap of problematic species between the countries in the region. With only 20 species, the total number of very problematic woody species in the region is rather small. There are between 5-10 most problematic woody species per country. Our document contains the first regional compilation of the main invasive woody species, and complements the few national overviews (Macdonald *et al.* 1991, Fleischmann 1997, Strahm 1999).

Compared to data on woody invasive species in the whole tropics (Binggeli *et al.* 1998), the invasive woody flora of the region has a higher proportion of large trees (41% vs. 21%), whereas shrubs are underrepresented (30% vs. c. 60%). In terms of taxonomy, the families of the Leguminosae (21% vs. 15%) and Myrtaceae (9% vs 3%) are overrepresented, and the families of the Rosaceae (1 species vs. 15%) and the Pinaceae (0 vs. 4%) are underrepresented among the most problematic invasive species in the region. In the Mascarenes c. 50% of the main invasive species are ornamentals, while this percentage is only about 15% in the Seychelles and the Comoros Archipelago.

Habitat invasibility

It is worthwhile looking at the interactions between invasive species and invaded habitats. A large proportion of invasive species preferentially invade disturbed, open, secondary habitats. These habitats are mostly of low biodiversity value. More problematic are species that invade habitats with a generally high resistance to invasions (low invasibility) (see table 3).

Habitat types	Description	Invading Species
Inselbergs (Seychelles)	Rocky granitic outcrops with a very high endemism and an abundance of exotics below 10% (Fleischmann <i>et al.</i> 1996)	<i>Alstonia macrophylla</i> , <i>Cinnamomum verum</i>
‘Padzas’/Bad Lands (Comoros)	Denuded dry areas with very poor soils modeled by large-scale erosion.	<i>Acacia mangium</i>
Volcanic Flows (La Réunion)	Early succession stages on young volcanic flows. One filter may be that they are mainly colonized by wind-dispersed species (Strasberg 1995)	<i>Casuarina equisetifolia</i>
Undisturbed Mountain Forests (all islands, except Rodrigues)	Mountain forests harbor most undisturbed closed canopy forests left in the region. They are invaded by species with a high shade-tolerance	<i>Ardisia crenata</i> , <i>C. verum</i> , <i>Clidemia hirta</i> , <i>Fuchsia</i> spp., <i>Ligustrum robustum</i> , <i>Litsea glutinosa</i> , <i>Psidium cattleianum</i> , <i>Syzygium jambos</i>
High Altitude Ericoid Vegetation (La Réunion & Comoros)	Shrub and heather vegetation above c. 2000 m asl.	<i>Ulex europaeus</i> , mainly invaded by herbs

Table 3. Habitat types that show a high resistance to invasions (low invasibility), and the few exotic species that are able to invade them.

The habitat specificity of invasive species may help to predict potentially invasive species in other regions. For instance, *Ulex europaeus*, invasive in La Réunion, may become a problem in similar habitats in the Comoros. *Alstonia macrophylla* is a drought-resistant, wind-dispersed tree, which grows in very bad and shallow soils on inselbergs and eroded laterite slopes in the Seychelles, and may be potentially invasive on volcanic flows in La Réunion or bad lands in the Comoros.

Impacts

The impacts were broadly classified into environmental impacts on natural systems, and economic impacts on anthropogenic systems.

Environmental Impacts

Environmental impacts were classified into three biological levels: genetic effects, impacts on biological interactions, and ecosystem effects.

For several exotic species the potential to hybridize with a native species has been shown, but in no case actual hybridization in the wild has been found so far.

The major environmental impact by invasive species perceived at present in the region is the reduction of the native regeneration through competition by exotic species. This

becomes most apparent with thicket-forming species such as *Chrysobalanus icaco*, *Clidemia hirta*, *Lantana camara*, *Psidium cattleianum*, *Ravenala madagascariensis*, *Rubus alceifolius*, or *Syzygium jambos*.

A mutualistic relationship between exotic fruits (notably *Psidium cattleianum*) and exotic animals has been proposed for La Réunion and Mauritius. In Mauritius the following hypothesis has been formulated : Fruit production of *P. cattleianum* in the austral winter when native fruit availability is generally low maintains high densities of pigs and monkeys. These exotic animals will then be at high densities at the end of the fruiting season of *P. cattleianum* when the main breeding season for native birds and the fruiting season for native trees begins. Monkeys cause significant damage to both native birds and trees. Pigs in turn disturb forest trees and ferns and may cause considerable damage to ground-dwelling invertebrates (J. Mauremootoo, pers. comm.).

In all countries, there are examples where rare endemic animals rely, at least partly, on exotic, secondary vegetation. In the case of the avifauna, the following examples can be given – endemic white-eye (*Zosterops modestus* in Seychelles, *Z. borbonicus* in La Réunion and Mauritius), endemic Fody (*Foudia rubra* in Mauritius, *F. flavicans* in Rodrigues), endemic Warbler (*Acrocephalus rodericanus* in Rodrigues), endemic Drongo (*Dicrurus fuscipennis* in Comoros). However, most endemic bird species seem to prefer or need native vegetation.

Leguminosae (e.g. several *Acacia* spp., *Paraserianthes falcataria*) and *Casuarina equisetifolia* are N-fixing species that have an ecosystem effect on nutrient cycling.

In the Mascarenes, exotic species generally prove to be less adapted to cyclones. Their higher vulnerability changes forest dynamics and increases the frequency of gaps. Gaps are often gateways for exotic invasions, and may increase soil erosion on steep slopes.

Casuarina equisetifolia is supposed to interrupt early successions on volcanic flows (Macdonald *et al.* 1991)

Economic Impacts

Concerns over agricultural woody weeds were mainly mentioned in the IFR Comoros (e.g. *Clidemia hirta*, *Lantana camara*, *Litsea glutinosa*, *Psidium cattleianum*). *Acacia nilotica* is a weed on rangeland in Rodrigues. Other agricultural weeds in the Mascarenes are for instance *Acacia mearnsii*, *Hiptage benghalensis*, *Homalanthus populifolius*, *Leucaena leucocephala* or *Rubus alceifolius*. In Seychelles creepers such as *Thunbergia grandiflora* or *Merremia peltata* are particularly perceived as very problematic weeds. Invasive species that are also agricultural weeds are an opportunity for awareness building, mainstreaming, and application of the existing legislation.

Besides agricultural weeds no major impacts on humans were mentioned for the region.

Part 2: Management priorities in the region

The section contains a compilation of past and present invasive plant species management approaches undertaken in the region and proposes present benchmarks and future priorities for four management aspects (prevention, control, habitat restoration, social and institutional framework).

Prevention

Preventive measures attempt to stop introductions of new potentially invasive species to a country, or further transport within the country (containment). Instruments for prevention at hand are awareness building, border control and quarantine with its supporting legislation, and screening systems and early detection mechanisms.

Awareness building is best developed in the Seychelles, where the issue of invasive species is covered in the media (newspaper, TV) at least monthly, and where 'Wildlife Clubs' and the Ministry of Environment actively involve school children and the general public in the control of invasive species.

Generally in the region awareness especially of decision makers is perceived to be low by invasive species experts. Invasive species management should become a national priority. Where conflicts of interest arise, a social marketing approach, where stakeholders develop solutions in a cooperative process, is more promising than mere informing. In Rodrigues, community-based restoration programs are very successful (Payendee this volume).

Legislation and border control mechanisms are well developed within the framework of plant protection under the respective Ministries of Agriculture. The plant protection unit of La Réunion is actively engaged in adapting the existing legislation and infrastructure for the case of invasive species (Le Bourgeois this volume).

A screening system for the identification of potentially invasive species is currently tested in La Réunion (Le Bourgeois this volume). The forestry service of La Réunion has institutionalised a mechanism for the early detection of exotic species in the field (Brondeau this volume).

Mechanical and chemical control

About 25 years of experiences of chemical and mechanical control of woody weeds exists in the region. In many countries it is the forestry service that has been the main agency involved in the control of invasive species, first in forest plantations, later for nature conservation purposes. However, these experiences are rarely adequately documented.

It should be a priority to define protocols for the documentation of control efforts that allow the assessment of their efficiency and negative impacts, as well as of the applicability of the method in other countries and habitats. The forestry service of La Réunion (ONF-Réunion) compiled its past control efforts and developed a method for their assessment (Brondeau this volume, Hivert 2003). The ongoing INVABIO research

project in La Réunion attempts to assess the impacts of mechanical control methods (Lavergne this volume).

Priorities for targeted species and areas have to be set. In La Réunion the computerized information system developed by Hiebert (<http://www.npwrc.usgs.gov/resource/2000/aprs/APRS.HTM> Hiebert 1996, Hiebert 2001) has been tested (Cazanove 1999).

Biological control

In La Réunion, two large-scale biological control research projects on *Rubus alceifolius* and *Ligustrum robustum* subsp. *walkeri* are about to finish (Le Bourgeois this volume).

Mauritius has a long history of past biological control attempts (for a review consult Fowler *et al.* 2000).

Biological control programs are expensive. Regional collaborations on species that are problematic in all countries, such as *Psidium cattleianum*, are advisable.

Habitat restoration

Continuous efforts of habitat restoration started about 15 years ago. Where well documented, the past experiences allow the development of more sophisticated methods that are more efficient and more effective in terms of conservation of the native biodiversity. The motto should be “to do as much as is needed but as little as is necessary”. Important aspects are the depletion of the exotic seed bank, the restoration of a native canopy, the reduction of the exotic propagule pressure (i.e. seed rain). Efforts should be fine-tuned to the specific species and habitats. Best practice is often a combination of mechanical, chemical control and ecosystem management (e.g. the currently investigated introduction of giant tortoises on Ile aux Aigrettes in Mauritius). Often past restoration projects are not well documented.

Comparative studies between restored and non-managed sites in Mauritius indicate that the impact on the native flora and fauna is ambiguous (mainly positive, but for some taxa neutral or even negative). Targets for habitat restoration should be more clearly defined, and negative and positive effects on the native fauna and flora monitored.

Habitat restoration so far has been done on isolated small offshore or mainland islands (0.5 to 30 ha). The role of these islands of native vegetation in the landscape is not well understood (propagule pressure, fragmentation, minimal viable populations, functioning of ecosystem processes). The landscape perspective should move to the centre of the interest.

A prerequisite of a landscape approach to habitat restoration is an up-scaling of restoration efforts. Currently not more than 20-100 hectares per country are actively managed.

Social and institutional framework

So far, no formal interagency network (national or regional), and no formal invasive species database (national or regional) exist. Currently, national invasive species committees have been set up in Mauritius, La Réunion, and the Seychelles.

In eco-tourism nature reserves, money generated from entry fees is partly used for habitat restoration (e.g. Ile aux Aigrettes in Mauritius; Planned National Park in La Réunion; Cousin, Aride, Vallée de Mai in the Seychelles; Moheli Marine National Park in the Comoros).

In the Seychelles, several luxury hotels on small islands do habitat restoration and rare species conservation on their islands.

In all countries except the IFR Comoros, the forestry sector is at the moment reorienting from production forestry to nature conservation and invasive species control.

The following main conflicts of interest have been identified in the region:

- *Psidium cattleianum* (Goyave de chine, Goyavier): The fruits of *P. cattleianum* are very appreciated in several countries (Mauritius, La Réunion, IFR Comoros).
- Horticulture industry: Many invasive species are ornamentals. New ornamentals are probably introduced every year. The importation of potentially invasive ornamentals is currently not regulated.
- Erosion control: Exotic species used in the past for erosion control became invasive (e.g. *Casuarina equisetifolia*, *Chrysobalanus icaco*). Currently, in the Seychelles *Acacia mangium*, a highly invasive species in the Comoros Archipelago, is planted for erosion control.
- Multi-purpose species in the IFR Comores: 70-80% of the population is still working in the agricultural sector where many invasive species are used.

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Plantes exotiques envahissantes : Méthodes de lutte mises en œuvre par l'Office National des Forêts à La Réunion

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Résumé

Les espèces exotiques envahissantes représentent la principale cause de perte de biodiversité dans les habitats naturels de La Réunion. Face à cette menace, une lutte active est mise en œuvre depuis les années 1980 par l'Office National des Forêts (ONF). Une étude de synthèse a été menée en 2002-2003 pour capitaliser et partager le savoir-faire progressivement acquis dans ce domaine. Ce bilan fait également apparaître plusieurs recommandations d'amélioration, dont certaines devront être mises en œuvre à l'échelle régionale (îles de l'Océan Indien).

Abstract

Invasive alien species are regarded as the main cause for the loss of biodiversity in the natural habitats of La Réunion. To face this threat, active control methods have been carried out by the Office National des Forêts (ONF) since the 1980's. A survey was conducted in 2002-2003 to capitalize and share the field experiences of the ONF staff. This assessment also brought out several recommendations for improvement, some of which should be carried out at a regional level (Indian Ocean islands).

1 Le problème des espèces exotiques envahissantes à La Réunion

Les éléments de cette section figurent de façon plus développée chez Kueffer *et al.* (2003).

1.1 Diversité, rareté et vulnérabilité des milieux

La Réunion est une île volcanique jeune à l'échelle géologique (2,1 millions d'années). L'activité volcanique, qui se poursuit, crée une importante variabilité géologique et pédologique (selon l'âge des coulées) et un relief extrêmement accentué. En outre, la présence de deux importants massifs montagneux au centre de l'île (point culminant à 3 070 m), combinée à l'effet des alizés (vents humides dominants de sud-est), entraîne de très forts contrastes climatiques (variation de la pluviométrie annuelle moyenne de moins de 1 000 mm à plus de 10 000 mm).

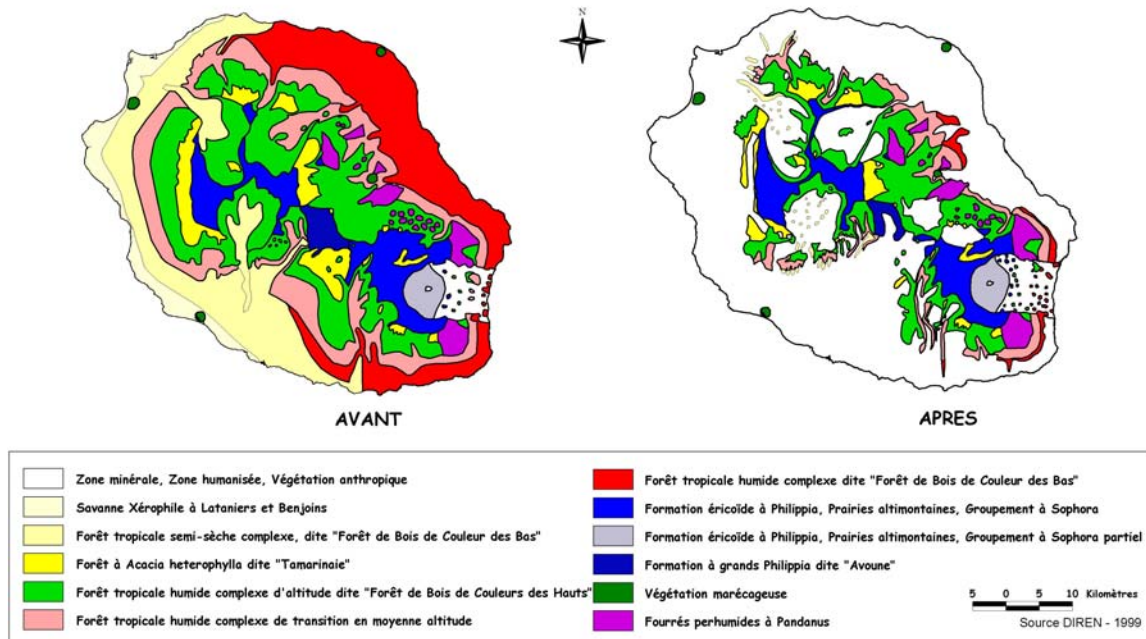
Ces facteurs physiques expliquent la très grande diversité de milieux et d'habitats (la plus importante des Mascareignes) rapportée à la faible superficie de l'île (2 512 km²). Cadet

(1977) distingue 4 grandes séries de végétation étagées selon l'altitude : mégatherme semi-xérophile, mégatherme hygrophile, mésotherme et oligotherme.

L'isolement propre aux îles océaniques est à l'origine d'une richesse spécifique indigène relativement faible (904 espèces de plantes vasculaires) mais caractérisée par un fort taux d'endémisme (26% d'endémiques strictes et 43% d'endémiques des Mascareignes parmi les plantes vasculaires) et une grande vulnérabilité (chiffres : Boulet, 2003, *comm. pers.*).

1.2 La place des espèces exotiques dans les écosystèmes réunionnais

Malgré des escales de navires entre le X^{ème} et le XII^{ème} siècle, l'occupation humaine définitive ne remonte qu'à 1663. Depuis cette date, environ 70% des milieux indigènes ont été détruits par vagues successives pour la mise en valeur agricole (coton, puis café, canne à sucre et géranium) et l'habitation (carte 1). Le relief et l'instauration d'un domaine forestier public en 1875 ont permis de préserver la majeure partie des milieux d'altitude et ceux de la région du Volcan malgré une très forte croissance démographique (environ 730 000 habitants en 2003). 80% des milieux naturels sont sous maîtrise publique.



Carte 1: Milieux indigènes de La Réunion avant et après la colonisation humaine (source : DIREN, d'après Cadet, 1977).

Les introductions volontaires ou accidentelles d'espèces exotiques ont commencé avant l'installation définitive de l'homme (plantes alimentaires, cochons, cabris, rats,...) mais se sont accélérées avec l'implantation humaine à des fins utilitaires (plantes alimentaires, médicinales, essences de reboisements) ou d'agrément. Ainsi, la quasi-totalité des plantes d'intérêt économique sont exotiques. Il est très difficile de chiffrer le nombre de plantes

introduites (plusieurs milliers) mais 53% de la flore vasculaire spontanée recensée en milieu naturel est actuellement constituée d'espèces exotiques (Boullet, 2003, comm. pers.). Les scientifiques admettent que plus d'une centaine d'entre elles ont atteint le statut d'envahissantes, à des degrés divers, et qu'autant sont potentiellement envahissantes.

Les différents milieux naturels sont atteints avec une intensité variable par les invasions biologiques, avec un gradient globalement décroissant avec l'altitude. Les reliques de milieux de basse altitude sont les plus menacées et leur régénération est très compromise, alors que les milieux de haute altitude, historiquement moins perturbés, présentent encore une assez bonne fonctionnalité.

1.3 La gestion des espèces exotiques envahissantes à La Réunion

La prise de conscience parmi les scientifiques du problème des espèces exotiques semble remonter à la fin du XIX^{ème} siècle mais elle est réellement devenue un sujet majeur de préoccupation à partir des années 1970. La sensibilisation des décideurs et financeurs locaux a permis de réaliser des chantiers de lutte à partir des années 1980 en leur attribuant des moyens croissants.

Un effort de recherche important a été entrepris sur les invasions biologiques, avec la publication au cours des dix dernières années de plusieurs thèses sur la biologie et la dynamique des espèces exotiques envahissantes (Strasberg, 1994 ; Lavergne, 2000 ; Baret, 2002 ; Tassin, 2002). Deux programmes de recherche pour la mise au point de méthodes de lutte biologique (*Ligustrum robustum* et *Rubus alceifolius*) et un programme de recherche sur l'impact des espèces exotiques envahissantes sur les écosystèmes (INVABIO) sont en cours et font l'objet d'une communication à cet atelier.

L'effort de communication et de sensibilisation auprès du grand public, lancé plus tardivement, n'a pas encore permis d'aboutir à une mobilisation collective autour du problème des invasions biologiques et les introductions d'espèces se poursuivent à un rythme soutenu, particulièrement les plantes ornementales. En attendant l'élaboration d'une réglementation spécifique aux espèces envahissantes, dont la mise en œuvre posera un gros problème de moyens, seule la réglementation sanitaire s'applique, dans un contexte de libre échange européen.

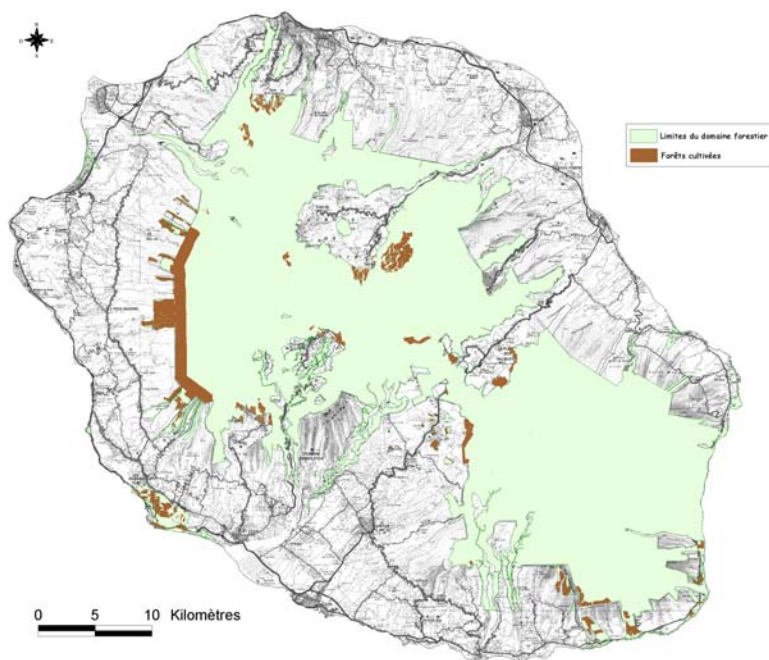
A l'initiative de la Direction Régionale de l'Environnement (Ministère de l'Ecologie), un comité des invasions biologiques regroupant les acteurs institutionnels, professionnels et associatifs de la gestion des espèces exotiques envahissantes a été institué en mars 2003. Il doit permettre d'échanger l'information entre ces acteurs, coordonner leurs actions et élaborer une stratégie de lutte à l'échelle de l'île.

2 L'action de l'ONF-Réunion contre les espèces exotiques envahissantes

2.1 Présentation de l'ONF

L'Office National des Forêts (ONF), qui succède au Service Forestier et à l'administration des Eaux et Forêt, est un établissement public d'état en charge de la

gestion des forêts publiques. A La Réunion, il gère un peu plus de 100 000 ha, dont la grande majorité est constituée de milieux naturels primaires plus ou moins bien conservés. Les forêts plantées ou exploitées ne représentent que 5% de la superficie gérée par l'ONF (carte 2).



Carte 2 : Domaine forestier géré par l'ONF à La Réunion (source : ONF-Réunion)

Les missions de l'ONF ont progressivement évolué pour accorder une place de plus en plus importante à la protection des écosystèmes et du patrimoine naturel, devenue aujourd'hui prioritaire. Face à une demande sociale croissante pour les loisirs de nature, l'ONF assure également la création et l'entretien de voies d'accès et d'équipements d'accueil du public. Enfin, il réoriente progressivement sa production de bois, développée à partir de 1950, vers des essences indigènes et à forte valeur ajoutée.

L'ONF emploie 95 personnels fonctionnaires, 240 ouvriers permanents et environ 400 emplois sociaux.

2.2 La politique de l'ONF en matière d'espèces envahissantes

L'ONF a d'abord développé des actions de lutte contre les espèces envahissantes dans un objectif sylvicole (notamment contre *Rubus alceifolius* en sous-bois de forêt de production à *Acacia heterophylla*). A partir du début des années 1980, et avec la mise en place progressive d'un réseau de réserves naturelles et biologiques, des actions de lutte ont commencé à être réalisées dans un objectif de restauration de milieux indigènes (Sigala, 1988). Des moyens financiers importants et croissants (de l'ordre de 300 k€/an) sont consentis par la Région Réunion et l'Union Européenne pour ce type de travaux.

Les espèces ciblées par ces travaux de lutte sont toutes déjà très établies et les actions visent un contrôle et non une éradication. Face à ce constat, l'ONF a mis en place fin 2002 une procédure de surveillance pour détecter les nouvelles invasions à un stade suffisamment précoce pour espérer un contrôle plus efficace et moins coûteux, voire une éradication.

2.3 Le bilan des méthodes de lutte

a) Objectifs

Après 20 ans de pratique de la lutte contre les espèces exotiques envahissantes, il devenait nécessaire pour l'ONF de réaliser un bilan pour évaluer ces pratiques, capitaliser le savoir-faire acquis mais éclaté entre les nombreux personnels de terrain et le faire partager au niveau régional et formuler des propositions d'amélioration et des pistes de recherche.

b) Méthodes

Ce bilan a été réalisé en 2002 et 2003 à partir d'enquêtes auprès de 32 agents territoriaux et de 3 associations. Chaque chantier a fait l'objet d'une fiche portant sur:

- Caractérisation du site : type de milieu, altitude, topographie,...
- Description de la méthode employée : surface traitée, saison de traitement, fréquence, temps de travail, outils et produits utilisés, dosages, devenir des rémanents, suivi, restauration effectuée...
- Évaluation de l'efficacité de la méthode selon une note variant de A (la plus efficace) à C (la moins efficace) ou a à c en cas d'emploi de phytocides. Cette note évalue uniquement la capacité de la méthode à éliminer l'espèce ciblée et ne tient pas compte d'autres éléments comme son coût ou son impact sur l'écosystème (perturbation du sol, destruction d'espèces indigènes, cascade d'invasions...)

c) Résultats et discussion

Espèces ciblées

61 méthodes, mises en œuvre sur 100 chantiers, ont été recensées et analysées. Elles concernent 18 espèces ou groupes d'espèces (tableau 1). 15 d'entre elles figurent dans la liste établie par Mac Donald *et al.* (1991), dont les 6 premières de leur classement. Ceci confirme que la lutte s'est opérée jusqu'à présent contre des espèces déjà bien établies. Les espèces les plus ciblées par la lutte sont *Rubus alceifolius*, *Hedychium spp.*, *Lantana camara*, *Solanum mauritianum* et *Fuchsia spp.*

A l'inverse, 5 espèces n'ont fait l'objet que de 1 ou 2 chantiers de lutte, généralement à titre expérimental (*Tibouchina viminea*, *Caesalpinia decapetala*, *Eucalyptus robusta*, *Clidemia hirta*, *Syzygium jambos*). Enfin, on note que certaines espèces reconnues comme envahissantes n'ont encore jamais fait l'objet de chantiers de lutte (*Ageratina riparia*, *Ardisia crenata*, *Casuarina cunninghamiana*, *Litsea glutinosa*, *Tecoma stans*, *Zanthedescia aethiopica*,...).

Ce choix d'espèces ne résulte, le plus souvent, pas d'une stratégie prédéfinie de l'ONF mais de choix individuels des agents de terrain ciblant les espèces qu'ils perçoivent comme les plus problématiques. Il est évident qu'une stratégie générale est nécessaire pour assurer la cohérence des actions menées et pour déterminer l'importance relative à

accorder au contrôle, à la détection précoce et l'éradication et à la prévention. Cette stratégie ne peut cependant que résulter d'une stratégie globale pour l'ensemble de l'île, y compris en dehors du domaine géré par l'ONF. Certains aspects devront également être établis à l'échelle régionale.

Nom scientifique	Nombre de chantiers par type de milieu				Méthodes de lutte			
	Milieu primaire	Plantation	Milieu secondaire	TOTAL	A / a	B / b	C / c	TOTAL
<i>Digitaria radicata.</i>								
<i>Panicum maximum.</i>	0	4	1	5	1 / 3	0 / 0	1 / 0	5
<i>Paspalum paniculatum.</i>								
<i>Hedychium gardnerianum</i>	5	5	2	12	1 / 0	2 / 0	1 / 2	6
<i>Hedychium flavescens.</i>								
<i>Strobilanthes hamiltonianus.</i>	1	2	0	3	0 / 0	0 / 0	1 / 2	3
<i>Agave vera-cruz</i>								
<i>Furcraea foetida.</i>	1	2	1	4	1 / 0	1 / 0	0 / 0	2
<i>Hiptage benghalensis</i>	3	0	0	3	0 / 0	1 / 0	0 / 1	2
<i>Caesalpinia decapetala</i>	0	0	1	1	0 / 0	0 / 0	1 / 0	1
<i>Clidemia hirta</i>	0	2	0	2	0 / 0	0 / 1	1 / 0	2
<i>Fuchsia magellanica.</i>								
<i>Fuchsia x exoniensis</i>	6	1	0	7	1 / 2	0 / 0	1 / 1	5
<i>Lantana camara.</i>								
<i>Ligustrum robustum subsp. walkeri</i>	3	3	3	9	1 / 1	0 / 0	1 / 0	3
<i>Ligustrum robustum subsp. walkeri</i>	1	3	0	4	0 / 2	1 / 1	0 / 0	4
<i>Rubus alceifolius</i>	11	10	6	27	2 / 5	2 / 2	1 / 1	13
<i>Solanum mauritianum</i>	3	2	4	9	0 / 4	1 / 0	1 / 0	6
<i>Tibouchina viminea</i>	1	0	0	1	0 / 1	0 / 0	0 / 0	1
<i>Ulex europaeus</i>	2	0	1	3	1 / 1	0 / 0	0 / 0	2
<i>Psidium cattleianum</i>	2	2	0	4	0 / 0	0 / 0	1 / 1	2
<i>Acacia mearnsii.</i>	0	3	0	3	1 / 0	0 / 1	0 / 0	2
<i>Eucalyptus robusta</i>	0	1	0	1	0 / 0	0 / 0	0 / 1	1
<i>Syzygium jambos</i>	2	0	0	2	0 / 0	0 / 1	0 / 0	1
TOTAL	41	40	19	100	9/19	8/6	10/9	61
					28	14	19	

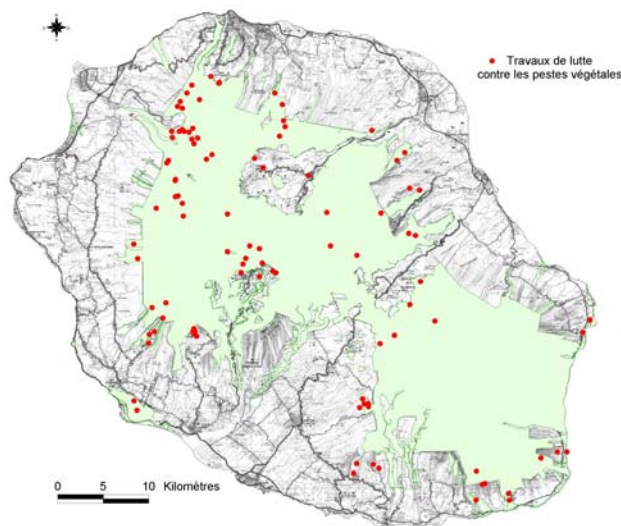
Ligne grisée : espèce pour laquelle l'ONF-Réunion dispose d'une méthode efficace (classée A ou a)

Tableau 1 : Bilan des méthodes de lutte pratiquées par l'ONF-Réunion

Milieus concernés par la lutte

La lutte s'opère aussi bien en milieu primaire (41% des chantiers) que dans des plantations (40%) ou en milieu secondaire (19%). Ceci provient de l'évolution des objectifs de la lutte, purement sylvicoles à l'origine et de plus en plus orientés vers la conservation. La proportion d'interventions en milieux primaires plus ou moins dégradés par les invasions biologiques devrait continuer à augmenter dans les prochaines années.

La lutte se fait et de façon plus intense près des limites du domaine forestier qu'au cœur de celui-ci (carte 3). Ceci résulte à la fois du meilleur état de conservation au cœur du domaine et des conditions d'accès.



Carte 3 : Localisation des chantiers de lutte contre les plantes envahissantes menés par l'ONF-Réunion

Efficacité des méthodes

11 espèces ou groupes d'espèces sur 18 font l'objet d'au moins une méthode classée A ou a et 28 méthodes sur 61 sont classées A ou a. Pour la majorité des espèces ciblées, il a donc été possible d'élaborer des méthodes de lutte relativement efficaces mais parfois à des coûts très élevés (en temps de main d'œuvre) et sans que l'effet global pour l'écosystème ait pu être évalué, faute d'états initiaux et de suivis scientifiques. Ce classement ne permet donc pas, à lui seul, de déterminer la méthode à retenir pour chaque chantier.

Avant de faire le choix d'une méthode, il est essentiel de bien définir l'objectif (contrôle, confinement, éradication), la surface concernée et les moyens disponibles. Ainsi, même lorsqu'il existe une méthode classée A, il est tout à fait possible de retenir une méthode classée B si elle s'avère beaucoup moins coûteuse ou moins perturbatrice du milieu.

Un protocole de suivi des méthodes de lutte a été proposé pour améliorer l'évaluation des méthodes de lutte (état initial, temps de travail nécessaire, coût total...) et permettre des comparaisons. Parallèlement, il est nécessaire de poursuivre les programmes de recherche tels qu'INVABIO visant à évaluer l'effet global des méthodes de lutte sur les écosystèmes.

D'autre part, 7 espèces (*Caesalpinia decapetala*, *Clidemia hirta*, *Eucalyptus robusta*, *Hiptage benghalensis*, *Psidium cattleianum*, *Strobilanthes hamiltonianus* et *Syzygium jambos*), dont certaines ont un impact très fort sur les milieux naturels, restent mal maîtrisées. 4 d'entre elles ne font l'objet que de méthodes classées C ou c. D'importants besoins en recherche fondamentale ou appliquée et en expérimentations de terrain sont nécessaires pour élaborer des méthodes plus efficaces. Cet effort de recherche pourrait, dans le cas des espèces communes à plusieurs îles de l'Océan Indien (*Psidium cattleianum*, *Clidemia hirta*,...) , être réalisé à l'échelle régionale.

Techniques et outils employés

27 méthodes sur 61 sont purement mécaniques. L'outillage reste rudimentaire : le sabre à cannes est le plus souvent utilisé, beaucoup plus rarement la pioche. Seule une méthode a recours à un outillage plus lourd et plus coûteux (broyeur). D'autres outils utilisés ailleurs dans le monde, et plus particulièrement dans d'autres îles de l'Océan Indien, mériteraient d'être essayés et de faire l'objet d'échanges de pratiques à l'échelle régionale (ex. : arracheur de mauvaises herbes « *weed wrench* »).

34 méthodes sur 61 font intervenir des phytocides, le plus souvent en association avec une intervention mécanique. Ce recours à des phytocides en milieu naturel pose le problème de leur devenir et de leur impact sur l'écosystème. Bien que s'agissant de produits homologués pour un usage en forêt, leur impact en milieu tropical, en particulier au sein des milieux primaires, reste mal connu et nécessiterait d'importants travaux de recherche. La mise en œuvre de ces phytocides entraîne des coûts importants qu'il conviendrait d'évaluer : formation spécialisée, équipements de sécurité, locaux de stockage,... Il est également important de se tenir informé des innovations techniques, notamment concernant les méthodes d'injection.

Le nombre relativement important de méthodes différentes employées (3,4 méthodes en moyenne par espèce, employées chacune en moyenne sur 1,5 chantier) fait ressortir une forte hétérogénéité des pratiques. Un classeur de fiches techniques a été élaboré pour tenter de normaliser les pratiques les plus efficaces. Il est, en outre, nécessaire de développer les échanges entre agents de terrain. Ces échanges peuvent s'appuyer sur des sites ateliers et doivent également s'envisager à une échelle régionale (Océan Indien) pour diffuser les meilleures techniques employées dans la région.

3 Conclusion : Recommandations à l'échelle régionale

Plusieurs recommandations sont susceptibles d'être mises en œuvre à l'échelle régionale :

- Élaborer une stratégie régionale de lutte contre les espèces exotiques envahissantes et des listes d'espèces « rouges » (risque maximum) ou « vertes » (risque minimum) ;
- Capitaliser et diffuser les techniques et les savoir-faire des opérateurs de terrain de la région Océan Indien en s'appuyant sur des échanges de pratiques et des formations communes ;
- S'engager plus activement dans la détection précoce en s'appuyant sur une base de données régionale sur les nouvelles espèces signalées ou en cours d'extension ;

- Mutualiser l'effort de recherche fondamentale ou appliquée sur la lutte contre les espèces exotiques envahissantes par des échanges de chercheurs ou d'étudiants et des programmes de recherche régionaux ;
- Gérer juridiquement la prévention et harmoniser les réglementations des différents pays de la région.

La mise en œuvre de ces recommandations devra s'appuyer à la fois sur un réseau d'experts, scientifiques ou décideurs sur les questions d'ordre stratégique et sur un réseau technique d'opérateurs de terrain.

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Actions de recherche et de réglementation sur les Espèces Exotiques Envahissantes à La Réunion

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Résumé

Les plantes envahissantes, au nombre actuel de 62 espèces, représentent une menace majeure pour les écosystèmes indigènes réunionnais, encore bien préservés et génèrent chaque année un coût de lutte très important.

Les actions de recherche dans ce domaine ont été principalement consacrées à l'étude des stratégies biologiques de quelques espèces particulièrement invasives (*Rubus alceifolius*, *Ligustrum robustum*, *Acacia mearnsii*...), de façon à comprendre les facteurs responsables de ces invasions, et aux moyens de lutte intégrée envisageables.

Plus récemment, l'étude de la distribution spatiale des invasions et de sa modélisation a été engagée. Ce travail porte sur les 10 espèces les plus menaçantes de la Réunion et permettra de modéliser leur potentiel d'extension dans les différents écosystèmes de l'île. Les résultats attendus doivent permettre d'orienter les programmes de gestion des milieux.

Les travaux menés sur la réglementation, ont porté sur l'adaptation, aux plantes exotiques envahissantes, des normes d'Analyse de Risque Phytosanitaire de l'Union Européenne élaborées pour les organismes nuisibles. Parallèlement, une liste des espèces à risques non encore présentes à la Réunion a été dressée.

Mots clés : adventice ; espèce exotique envahissante ; milieu insulaire ; Réunion ; Océan Indien ; recherche ; réglementation ; invasion biologique ; lutte biologique ; modélisation

Abstract

Alien Invasive Species, a total of 62 at present, are the main threat for indigenous ecosystems still well preserved in Réunion. They generate a high control cost every year.

Research activities in this area have mainly focused on the biological strategy of some very invasive species (i.e. *Rubus alceifolius*, *Ligustrum robustum*, *Acacia mearnsii*, ...). The aim of this work has been to understand which factors were responsible for the invasion process and how this understanding would aid possible integrated control measures.

Recently spatial distribution of invasions and modelling studies have been initiated. This work concerned the 10 of the most threatening species to La Réunion and will allow us to model their potential to invade ecosystems. Results will help us to adapt ecosystem management programs.

Regulation activities undertaken have been geared towards the adaptation of the European pest phytosanitary risk assessment protocol to invasive alien plants. At the same time, we have listed risk species not yet introduced in Réunion Island.

Key words: weed, invasive alien species, island, La Réunion, Indian Ocean, research, regulation, biological invasion, biological control, modelling

Introduction

Conformément à la définition de la CBD¹, nous entendons par *Espèce exotique envahissante* toute espèce exotique dont l'introduction (intentionnelle ou non intentionnelle) et la propagation menacent économiquement et/ou écologiquement des écosystèmes, des habitats ou d'autres espèces ainsi que la santé humaine.

Si l'impact économique (150 000 € consacrés en 1997 à la Réunion pour la lutte contre les plantes envahissantes) et environnemental (dégradation des milieux indigènes, perte de biodiversité) des plantes envahissantes est énorme, il ne faut pas pour autant en conclure que toute nouvelle espèce introduite devient forcément envahissante (règle des 10%). A titre indicatif, le tableau 1 présente le taux d'introduction, de naturalisation et d'envahissement par les plantes dans différents pays et îles du Sud Ouest de l'Océan Indien, par rapport à l'importance de la flore indigène.

Pays	Flore indigène	Nombre d'espèces introduites	Nombre d'espèces naturalisées	Nombre d'espèces envahissantes	Référence biblio.
La Réunion	915	2000	628	62	(Lavergne, 1999) (Macdonald et al., 1991)
Ile Maurice	685	1090	731	50	(Strahm, 1989; 1994)
Rodrigues	128	475	280	10	(Strahm, 1989; 1994)
Afrique du Sud	24000	8750		161	(van Wilgen et al., 2002)

Tableau 1 : Recensement de plantes indigènes, introduites et envahissantes dans différents pays de l'Océan Indien

Le problème des plantes exotiques envahissantes à la Réunion est signalé depuis très longtemps. Du début du 19^{ème} siècle jusqu'à nos jours, de nombreux botanistes ont attiré l'attention sur le nombre et l'importance de ces espèces. Par exemple, *R. alceifolius* aurait

¹ UNEP/CBD/COP/6/18/Add.1

été introduit dans l'île dans les années 1840 et était déjà signalée comme envahissante dès la fin du siècle. Au début des années 1980, le problème de la lutte contre les pestes végétales forestières est officiellement évoqué, et l'ONF², gestionnaire des milieux forestiers, entreprend des essais de lutte chimique et mécanique. A la fin des années 80, l'idée de l'utilisation de la lutte biologique est avancée pour lutter contre certaines espèces majeures. En 1991, Macdonald *et al.* hiérarchisent les problèmes des plantes envahissantes à la Réunion (Macdonald *et al.*, 1991). Cette hiérarchisation a servi de base pour la mise en œuvre, à partir de 1997, de deux premiers programmes de recherche sur la lutte contre *R. alceifolius* (Amsellem, 2000; Baret, 2002; Baret *et al.*, 2003). et *Ligustrum robustum* var. *walkeri* (Lavergne, 1999; 2000) considérés d'intérêt prioritaire. D'autres espèces comme *Acacia mearnsii* (Tassin, 2002) ont également fait l'objet de travaux de recherche.

Ces dernières années, la capacité à prédire les risques d'invasion en un lieu donné d'une espèce non encore présente ou seulement naturalisée est devenue un enjeu majeur dans la prévention des risques d'invasion biologique (Smith *et al.*, 1999). C'est pourquoi parallèlement à l'étude des plantes et de leurs moyens de lutte, différentes actions ont été engagées :

- L'une porte sur des études de spatialisation et de modélisation des invasions en vue d'une aide à la gestion des milieux.
- L'autre, porte sur la mise au point d'analyses de risques d'invasion en vue d'une amélioration de la réglementation des échanges de matériel végétal, régionaux et internationaux.

A la Réunion, différents acteurs travaillent sur les Espèces Exotiques Envahissantes en milieu terrestre. Les actions de recherche sont assurées par l'Unité Mixte de Recherche Cirad/Université de la Réunion avec la participation du CBNM³. La mise en œuvre des pratiques de lutte et de gestion des milieux envahis relève principalement de l'ONF et dans une moindre mesure du CBNM et du CG⁴. Les actions de réglementation sont du ressort de la DIREN⁵ et du SPV⁶.

1 Stratégies d'invasion et invasiabilité des écosystèmes

Les processus d'invasion biologique peuvent être considérés comme une combinaison d'événements évolutifs et de facteurs environnementaux et anthropiques qui interagissent au bénéfice du développement d'une espèce. Ces interactions doivent être prises en considération pour comprendre les causes et les conséquences des invasions de certaines espèces et de l'invasiabilité de certains écosystèmes (di Castri, 1989).

² ONF : Office National des Forêts

³ CBNM : Conservatoire Botanique National de Mascarin

⁴ CG : Conseil Général de la Réunion

⁵ DIREN : Direction Régionale de l'Environnement

⁶ SPV : Service de la Protection des Végétaux

Si l'homme est généralement responsable (de façon volontaire ou involontaire) du transport et de l'introduction des espèces vers de nouveaux habitats, ce sont les caractéristiques écologiques, biologiques (croissance, reproduction, dissémination) et génétiques des espèces qui leur permettent de coloniser et d'envahir.

L'étude des stratégies d'invasion d'une plante envahissante et notamment la comparaison des processus entre aire d'origine et aire d'introduction a pour objectif de comprendre les caractères de l'espèce et les facteurs environnementaux qui ont permis à l'espèce de devenir envahissante dans un contexte écologique nouveau. L'ensemble des informations acquises au travers de ces études doit permettre la mise au point de méthodes de lutte intégrée.

L'étude de diversité génétique fait appel aux techniques de biologie moléculaire (AFLP, Microsatellites...). Elle peut être réalisée à différentes échelles :

A l'échelle d'une île ou d'un pays, elle nous renseigne sur le degré d'homogénéité génétique de la population. A l'échelle de l'ensemble des régions d'introduction, le degré de diversité génétique permet d'évaluer la possibilité d'extrapolation et de diffusion d'une méthode de lutte mise au point localement. Ceci est particulièrement important pour les méthodes de lutte biologique. La comparaison entre les populations de l'aire d'origine et de l'aire d'introduction est réalisée dans le but de localiser l'origine génétique et géographique exacte de la population de la plante envahissante, notamment en vue de rechercher dans cette région les agents naturels de régulation. Elle permet également de comparer le mode de reproduction de la plante dans les deux situations.

L'analyse écologique porte sur l'étude des conditions abiotiques (climat, sol, fréquence des perturbations, degré de dégradation de l'habitat) qui constituent le milieu physique dans lequel les espèces introduites devront se développer. De plus, la composition et le fonctionnement des écosystèmes vont influencer sur les phénomènes de régulation des populations, notamment au travers des interactions inter-plantes et entre plantes et ennemis naturels.

L'étude de la croissance et de la reproduction s'intéresse plus particulièrement à la façon dont la plante exploite le milieu, le colonise et se propage dans l'espace et dans le temps. L'expression des différents caractères biologiques et écologiques des plantes sera influencée par les pratiques anthropiques appliquées aux milieux dans lesquels ces plantes envahissantes se développent.

A titre d'exemple nous pouvons synthétiser les résultats obtenus sur deux modèles de plantes envahissantes aux caractéristiques différentes étudiées à la Réunion : *R. alceifolius* et *L. robustum* :

La population de *R. alceifolius* est clonale à la Réunion et, par ordre de similitude, génétiquement très proche des populations de Maurice, Queensland, Mayotte et Madagascar, tandis qu'une grande variabilité est observée dans l'aire d'origine. De plus, les populations de l'aire d'introduction sont génétiquement très éloignées des populations étudiées dans l'aire d'origine (Asie du sud-est). Il n'a donc pas été possible de retrouver

l'origine de cette population. L'hypothèse d'un croisement entre une espèce asiatique introduite à Madagascar et d'une espèce indigène (*R. voridus*) a été émise. La reproduction par graine est principalement allogame dans l'aire d'origine, tandis qu'elle est essentiellement apomictique dans l'aire d'introduction (Amsellem *et al.*, 2000). A la Réunion, *R. alceifolius* est un buisson lianescent épineux, qui se développe de 0 à 1600 m d'altitude en zone humide et de 400 à 1700 m d'altitude en zone sèche. Il se multiplie, à basse altitude, par graines dont la dormance est longue (10 ans) et la germination liée à l'ouverture du milieu. Les graines sont dispersées à faible distance par barochorie et ruissellement et à longue distance par les oiseaux frugivores. La propagation végétative par marcottes et par boutures est importante à toutes altitudes. Il envahit les milieux éclairés secondarisés (friches, bords de champs ainsi que les trouées forestières et les forêts claires). Son développement est grandement favorisé par toute ouverture du couvert végétal (coupe, chemin...). Dans l'aire d'introduction il ne fait l'objet d'aucun ennemi naturel notable. Dans son aire d'origine, sa vigueur et sa croissance sont moindres et de nombreux ennemis naturels régulent son développement. Au cours de prospections, 27 insectes et 3 pathogènes ont été recensés parmi lesquels les plus remarquables, par les dégâts qu'ils produisent, sont *Cibdela janthiana* (Tenthrede), *Phaedon fulvescens* et *Cleorina modiglianii* (Chrysomèles), *Gerwasia rubi* et *Hamasporea acutissima* (Rouilles). Les rouilles se sont montrées trop spécifiques pour attaquer le *Rubus* réunionnais, en revanche la tenthrede doit être introduite en quarantaine à la Réunion pour des tests complémentaires.

L'étude réalisée sur *L. robustum* montre que les populations réunionnaises et mauriciennes présentent une certaine diversité génétique mais qu'elles sont très proches de la population du Sri-Lanka, contrairement à celle du sud de l'Inde (Shaw & Milne, 1999). A la Réunion, *L. robustum* est un arbuste ligneux de 2,5 m, qui se développe en populations denses pluri-strates, en lisière forestière et en sous-bois semi-sombre, dans des forêts pas ou peu perturbées. Au Sri-Lanka c'est un arbre de 2 à 9 m de hauteur, aux individus isolés à rares se développant en lisière mais jamais en sous-bois. Il se multiplie par graines (dispersion par les oiseaux frugivores) et multiplication végétative par rejet de souche. La production de fruits est beaucoup plus importante à la Réunion (2888 fruits/m² de feuillage) qu'au Sri-Lanka (415 fruits/m² de feuillage). De même, la densité peut atteindre 180 plantules/m² à la Réunion pour seulement 0,013 plantule/m² au Sri Lanka. Les graines ne présentent pas de dormance, la germination est rapide et massive. Les prospections réalisées dans l'aire d'origine ont montré qu'il était attaqué par de nombreux pathogènes et insectes, parmi lesquels le lépidoptère *Epiplema albida* est apparu comme un agent de lutte biologique intéressant.

Du fait de leurs caractéristiques biologiques et des milieux envahis, chacune de ces espèces peut être considérée comme une plante modèle pour les phénomènes d'invasion biologique :

3 Mise au point de méthodes de lutte intégrée

L'intégration des résultats acquis sur les stratégies biologiques des espèces et les milieux envahis ont permis de proposer des méthodes de lutte intégrées à l'échelle de l'île. Pour *R. alceifolius* la lutte biologique avec *C. janthiana* est préconisée dans les bas de

l'île, là où la plante fructifie abondamment. En milieu forestier il est proposé de réduire au maximum les ouvertures de milieu et de favoriser la fermeture rapide de la végétation indigène lors d'accidents. La lutte mécanique doit être effectuée préférentiellement en saison hivernale pour minimiser le bouturage et doit s'accompagner d'un arrachage des souches avec mise à sécher. Les zones non encore ou peu contaminées (Mafate, Cilaos) doivent faire l'objet d'une surveillance régulière et d'une éradication systématique.

Pour *L. robustum*, l'objectif principal est de limiter la production de graines. Il convient en priorité de contrôler les milieux ouverts favorables à la fructification et à la dispersion, et d'éviter l'ouverture des milieux forestiers denses. Il faut lutter de façon prioritaire contre les pieds mères en âge de fructifier. Une régulation à long terme est proposée par lutte biologique avec *E. albida* qui doit être introduite en quarantaine pour des tests complémentaires.

4 Spatialisation et modélisation des phénomènes d'invasion biologique

L'Université de La Réunion et l'Institute of Plant Conservation (Université du Cap) ont établi un projet de coopération scientifique (2001-2002) sur la diversité et la transformation des habitats de La Réunion. Cette étude s'intègre dans un projet plus vaste vers une planification systématique de la conservation à La Réunion.

- La première étape de ce projet a été d'identifier et de représenter (échelle:1:50000^{ème}) les 19 principaux types de milieux à La Réunion et leur degré de transformation.
- La deuxième étape (2003-2004) a pour objectif d'établir la distribution spatiale et l'abondance de l'ensemble des espèces exotiques à la Réunion.

A l'échelle de l'île, de nombreux relevés (effectués par R. et C. Lavergne), permettront de représenter la répartition de l'ensemble des espèces exotiques présentes en bordure des voies de circulation.

Pour chacune des ZNIEFF (*Zones Naturelles d'Interêt Ecologique Floristique et Faunistique* - constituées en grande majorité par des milieux naturels), la distribution et l'abondance des différentes espèces exotiques seront cartographiées.

A l'échelle des différents habitats des ZNIEFF, la distribution et l'abondance des 10 espèces exotiques les plus menaçantes seront étudiées.

Ce travail, permettra d'évaluer la distribution actuelle et future de ces espèces envahissantes sur l'île. Il fait appel à une combinaison d'outils de télédétection (complétés par des relevés de terrain), de statistiques et de modélisation. Les résultats obtenus au travers de cette étude constitueront une source d'information indispensable pour élaborer et orienter les programmes de gestion des milieux. Ces nouvelles données viendront alimenter l'observatoire (en cours de formation) des espèces exotiques à caractère envahissant à La Réunion. Cette étude permettra également de préciser les capacités de colonisation de *R. alceifolius* et de *L. robustum* et d'assurer un suivi de l'impact des agents de lutte biologique qui doivent être introduits dans le cadre des programmes de lutte biologique en cours.

5 Réglementation et prévention des introductions

Pour réglementer, des règles internationales sont incontournables. Ainsi, les réglementations phytosanitaires aux frontières doivent obligatoirement respecter l'accord sur les mesures sanitaires et phytosanitaires (SPS) de l'Organisation Mondiale du Commerce (OMC). Cet accord a pour objectif d'éviter que des mesures phytosanitaires injustifiées soient des obstacles déguisés au commerce international. Les mesures doivent être fondées sur des principes scientifiques et être compatibles avec les normes et directives internationales. Dans cet objectif, les analyses de risque sont utilisées. C'est un processus qui consiste à évaluer les preuves biologiques ou autres données scientifiques ou économiques pour déterminer si un organisme nuisible doit être réglementé et la sévérité des mesures phytosanitaires éventuelles à prendre à son égard.

Des normes internationales adoptées par la Convention Internationale pour la Protection des Végétaux⁷ existent. Sur la base de ces normes, l'OEPP (organisation européenne et méditerranéenne de protection des plantes), dont la France est membre, a développé différentes normes d'analyse de risque pour les organismes nuisibles (virus, bactéries, champignons, insectes, arachnides) des cultures. Ces normes sont peu adaptées à l'analyse de risque des végétaux envahissants des milieux naturels et cultivés. Cependant, l'OEPP encourage les organisations nationales de protection des végétaux à travailler sur les plantes envahissantes et notamment sur l'analyse et la gestion du risque.

A La Réunion, toute introduction de végétaux et produits végétaux aux frontières est contrôlée par le Service de la Protection des Végétaux de la Direction de l'Agriculture et de la Forêt de La Réunion (SPV/DAF) qui applique une réglementation phytosanitaire spécifique au contexte local. Jusqu'à présent, cette réglementation n'intègre pas les plantes envahissantes des milieux naturels et que très partiellement les plantes envahissantes des milieux cultivés. Or, cette réglementation est actuellement en cours de révision. Dans ce contexte, il semble nécessaire d'intégrer les espèces végétales envahissantes à la prochaine réglementation phytosanitaire.

Le SPV de La Réunion a réalisé un premier travail sur l'adaptation des normes OEPP d'analyses de risque, aux plantes envahissantes. Des critères propres aux plantes (notamment à leur caractère envahissant) et aux milieux (caractéristiques des sols, milieux perturbés...) y sont intégrés. Une importance particulière est accordée aux impacts environnementaux et sociaux. Le protocole (toujours en évolution) est régulièrement soumis aux scientifiques locaux pour validation.

Ce protocole a été testé au travers de l'évaluation du risque que présente *Chromolaena odorata* (L.), envahissante dans de nombreux pays, présente à Maurice mais encore absente à la Réunion. Le potentiel d'établissement est évalué à l'aide d'un logiciel de comparaison climatique et de simulation dynamique CLIMEX®. Les impacts

⁷ La CIPV est un traité multilatéral adopté en 1951, déposé à la FAO et administré par le secrétariat de la CIPV au sein de la FAO. Le texte actuel fait suite à la création de l'OMC et intègre les principes de l'accord SPS. La CIPV a pour objet de garantir une action internationale commune et efficace pour éviter la dissémination et l'introduction d'organismes nuisibles aux végétaux cultivés et non cultivés dans les écosystèmes cultivés et naturels et de promouvoir des mesures permettant leur contrôle.

économiques, environnementaux et sociaux sont analysés. L'analyse de risque montre que *C. odorata* présente un risque élevé pour les milieux naturels et cultivés de La Réunion. L'étape de gestion du risque déterminera les mesures réglementaires à prendre à son égard.

Parallèlement, une liste de plantes potentiellement envahissantes et non présentes à La Réunion a été constituée à partir d'une liste de référence de 1993 et de listes d'alerte de régions présentant des caractéristiques climatiques proches de celles de la Réunion : les îles du Pacifique, le Queensland (Australie) et la Floride. Chaque espèce de cette liste devra être soumise à une évaluation du risque avant d'être réglementée. Aujourd'hui, la liste comprend 611 espèces de 112 familles. Elle doit être validée par les experts locaux. Il est nécessaire d'y ajouter les espèces envahissantes de l'Océan Indien qui présentent le risque d'introduction le plus important pour La Réunion. Un inventaire de ces espèces est indispensable. Une fois complétée et validée, la liste de plantes potentiellement envahissantes à La Réunion pourra servir de base à la création d'une liste d'alerte régionale.

Discussion et conclusion

Le travail de recherche présenté au travers de quelques exemples s'inscrit dans un contexte global de lutte contre les plantes exotiques envahissantes à la Réunion et de façon plus générale dans les milieux insulaires tropicaux.

La seule recherche sur les processus d'invasion biologique ou la mise en oeuvre de moyens de lutte ne peut résoudre ce problème que de façon ponctuelle. Aussi, une réflexion est en cours pour la mise en oeuvre d'une stratégie globale de gestion du problème des espèces exotiques envahissantes à l'échelle de la Réunion.

Cette démarche s'appuie sur les travaux développés actuellement à l'échelle internationale, notamment au travers du GISP⁸, de la CDB⁹ et de l'UICN¹⁰ (CRAWM, 2001; Glowka *et al.*, 1996; McNeely, 2001; McNeely *et al.*, 2001; Mooney, 1999; SCBD, 2001a; b; 2002; Wittenberg & Cock, 2001).

Il s'agit d'organiser et de coordonner les actions aux différentes étapes des phénomènes d'invasion.

La prévention est une étape majeure de limitation des invasions, permettant d'éviter toute introduction d'organisme vivant, susceptible d'être indésirable. Cette prévention nécessite une information régulière, de la population et des structures de transports internationaux, sur les risques liés à l'introduction d'organismes vivants en milieu insulaire. Elle nécessite également l'établissement de listes d'espèces dont l'interdiction d'introduction est basée sur des Analyses de Risques Phytosanitaires adaptées au contexte local. Ces procédures permettent d'affiner la réglementation régulant les

⁸ GISP : Global Invasive Species Programme

⁹ CDB : Convention sur la Diversité Biologique

¹⁰ UICN : Union Internationale pour la Conservation de la Nature

importations de matériel vivant et les contrôles aux points d'entrée sur le territoire, dans le respect des accords Sanitaires et Phytosanitaires de l'OMC.

La deuxième étape concerne la détection précoce des espèces récemment introduites et en cours d'installation. Elle doit faire l'objet d'un réseau d'observation et de signalement à partir de sites sentinelles et de la surveillance des espèces reconnues envahissantes sur le territoire et de toute nouvelle espèce. Ainsi, toute nouvelle espèce recensée fait l'objet d'une analyse de risque permettant de statuer sur le risque d'invasion qu'elle représente pour l'île. Ceci permet d'engager des actions de lutte et d'éradication pour une espèce dont la répartition reste limitée.

Les espèces exotiques largement répandues font l'objet d'une analyse d'impact afin de hiérarchiser le degré de nuisibilité de chacune d'elle et d'engager des études sur les moyens de lutte intégrée (mécanique, chimique, biologique...) à mettre en œuvre à plus long terme.

A l'échelle de la gestion des territoires et des écosystèmes, il est important de pouvoir prévoir les risques d'invasion. L'approche de la modélisation spatiale, par SIG, des invasions biologiques en fonction des milieux est pour cela très intéressante (Rouget *et al.*, 2001).

L'ensemble des informations acquises sur les espèces exotiques à caractère envahissant doit être synthétisé en bases de données et rendu accessible à tous, décideurs politiques, gestionnaires, contrôleurs, scientifiques, public, etc. de façon à agir de manière coordonnée contre les phénomènes d'invasion biologique à l'échelle de l'ensemble de l'île et de la sous-région.

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Apport de la recherche dans les programmes de restauration écologique : l'exemple du projet de recherche « Invasions Biologiques *INVABIO* » à La Réunion

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Résumé

L'île de La Réunion possède des espèces, des habitats, des écosystèmes originaux, uniques au monde. Beaucoup d'entre eux sont en voie de disparition ou sont très menacés. Il serait dommage d'accélérer leur dégradation et leur extinction. Les invasions végétales sont nombreuses à La Réunion et constituent actuellement la première cause d'appauvrissement de la biodiversité et des écosystèmes de l'île. De nouvelles espèces sont introduites chaque année et le risque de nouvelles invasions augmente également. Les invasions représentent un coût écologique et économique important.

Maintenir la biodiversité et les habitats indigènes en contrôlant les menaces (invasions, urbanisation, incendies...) constitue un des enjeux majeurs de ce siècle. La restauration écologique des habitats est indissociable du contrôle des espèces envahissantes.

Il existe peu de suivi de l'impact des plantes envahissantes accompagnant les efforts de restauration dans toutes les îles de l'Océan Indien. Il est donc urgent d'entreprendre un travail de recherche et de suivis de l'impact du contrôle des invasions.

Dans le cadre du programme de recherche national Invasions Biologiques "*INVABIO*", le Conservatoire Botanique National de Mascarin, l'Université de La Réunion et l'Office National des Forêts de La Réunion cherchent à évaluer ensemble l'impact des plantes envahissantes et de leur contrôle sur les écosystèmes indigènes insulaires. Il s'agit de comprendre le processus de restauration écologique à l'échelle de l'écosystème pour l'améliorer. Les résultats des recherches sont attendus pour la fin 2004 et viendront appuyer les choix et les pratiques des gestionnaires des milieux naturels.

Mots clés : Impact du contrôle des invasions, plantes exotiques envahissantes, écosystème indigène insulaire, Ile de La Réunion.

Abstract

The species, habitats, original ecosystems of La Réunion Island are unique in the world. Many of them are on the way of extinction or are very threatened. It would be a shame to accelerate their degradation and their extinction. Several alien invasive plants exist in La

Réunion and constitute now the greatest threat to the biodiversity and ecosystems of the island. New species are introduced each year and the risk of new invasions also increases. The invasions represent an important ecological and economic cost.

To maintain the indigenous biodiversity and habitats by controlling the threats (invasions, urbanization, fires...), constitute one of the major challenges of this century. The ecological restoration of the habitats is inseparable from the control of alien invasive species.

The monitoring of the impact of invasive alien plants in the Indian Ocean islands is still needed to accompany the restoration efforts. Thus, it is urgent to undertake a work of research and monitoring of the impact of the invasions and their control.

Within the framework of the national research programme *Invasions Biologiques* "INVABIO", the Conservatoire Botanique National de Mascarin, the University of La Réunion and the National Forest Service are attempting to evaluate the impact of invasive plants and their control on the island native ecosystems. The aim is to understand the process of ecological restoration at the ecosystem level in order to optimise it. The results of research are awaited for the end of 2004 and will support the choices and the practices of the managers of the natural habitats.

Key words: Impact of the control of invasions, alien invasive plants, island native ecosystems, La Réunion island.

Introduction : problématique des invasions biologiques à La Réunion

Les invasions végétales sont nombreuses à La Réunion. Si on considère que la déforestation a cessé, elles constituent la principale cause d'appauvrissement de la biodiversité et de transformation des écosystèmes indigènes de l'île.

Les espèces introduites sont plus nombreuses que les espèces indigènes. Pour la faune, 12 espèces de mammifères (chèvres, cerfs, rats, tangué, furet...), 24 oiseaux, 14 reptiles et 2 batraciens ont été introduits.

Plus de 2000 espèces de plantes, qualifiées d'*exotiques*, ont été introduites dans l'île (contre 550 Plantes à Fleurs indigènes, dont 388 endémiques). Environ 700 espèces se sont naturalisées et 130 sont devenues envahissantes. Une trentaine d'espèces exotiques envahissantes sont capables d'envahir des écosystèmes indigènes peu ou non perturbés par les activités humaines (C. Lavergne, non publié). Environ 140 espèces ont été identifiées comme potentiellement envahissantes à La Réunion (C. Lavergne, non publié).

Avant l'arrivée de l'homme et pendant 3 million d'années, l'intervalle théorique séparant l'arrivée de 2 souches de Plante à Fleurs était inférieur à 30 000 ans (Cadet 1980 : 31). Si on considère que l'homme a introduit en moyenne 10 espèces par an depuis 300 ans, le

taux d'introductions est multiplié par 300 000. De nouvelles espèces sont donc introduites chaque année et le risque de nouvelles invasions augmente également.

De plus, des interactions nouvelles entre espèces animales et végétales introduites se sont créées. Plantes et animaux agissent parfois en synergie pour envahir les habitats indigènes. Un exemple est celui de la dissémination des fruits et graines de plantes envahissantes par des oiseaux frugivores généralistes (*Pycnonotus jocosus* et *Acridotheres tristis*).

L'impact humain est récent et relativement bien documenté, alors que l'impact des invasions est moins bien connu.

Marquée par 300 ans d'histoire humaine, La Réunion est la 6^{ème} île au monde ayant connu les plus fort taux d'extinction (Walter & Gillet 1997). Certains habitats sont réduits et très fragmentés (forêts humide des Bas et semi-sèche). Les deux tiers des habitats naturels ont été convertis en formations secondaires, constituées principalement d'espèces introduites. Cependant, 30 % de la surface de l'île est encore couverte de milieux naturels quasiment intact. Les incendies et la surexploitation des ressources (chasse, collecte, braconnage) ont aussi un impact important.

Si l'impact écologique des invasions végétales n'a pas réellement été mesuré, l'impact économique peut être apprécié par le coût de la lutte menée depuis 15 ans sur le domaine forestier géré par l'Office National des Forêts.

Le coût moyen pour restaurer respectivement un hectare de forêt humide de basse altitude et un hectare de forêt semi-sèche est de 46 000 euros et 24 000 euros (Sigala 1999).

Une expérience d'éradication du Longose envahissant (*Hedychium gardnerianum*) a permis d'estimer que pour arracher 70 tonnes de Longose sur 1 hectare, il fallait 230 jours (1375 heures) pour un coût de 21 315 euros (CBNM 2003).

Le principal challenge pour l'avenir est de :

- Conserver la biodiversité, les habitats et les écosystèmes indigènes et leur fonctionnement ;
- Gérer des menaces en contrôlant les invasions, le développement démographique, les incendies, la surexploitation des ressources naturelles...de façon raisonnée ;
- Restaurer les habitats les plus menacés.

Nécessité de suivre l'impact des invasions et de leur contrôle à l'échelle des écosystèmes

Aujourd'hui, peu de suivis de l'impact des plantes envahissantes ont été réalisés dans les îles de l'Ouest de l'Océan Indien. Il existe peu de données disponibles sur la gestion des plantes envahissantes et de leurs impacts sur les invertébrés, les plantes épiphytes, les mycorhizes... (Kueffer *et al.* 2003).

L'impact des plantes exotiques envahissantes est difficile à mesurer. Il est rarement exprimé de façon quantitative et souvent sans prendre en compte un état initial de référence. Richardson *et al.* (2000) estime que seulement 10 % des plantes envahissantes ont un impact majeur sur les habitats indigènes, et demandent donc à être contrôlées ou éradiquées. Cependant, l'éradication des plantes exotiques envahissantes peut provoquer d'importantes perturbations, telles que l'augmentation de la lumière, le changement de la structure du sol, l'envahissement par d'autres espèces...

Les expériences d'éradications sont nombreuses dans les îles et trop souvent hâtives sans suivi à long terme. Les essais de contrôle sont réalisés au coup par coup sur quelques espèces cibles. Les éradications hâtives peuvent aboutir à des résultats inverses aux résultats attendus et provoquer le déclin en cascade de populations d'espèces endémiques. Il est donc urgent qu'un travail de recherche et de suivis de l'impact des plantes exotiques et de leur contrôle soit réalisé.

Apport du programme *INVABIO* pour la recherche et la gestion des espèces qui envahissent les habitats indigènes

Dans le cadre du programme national de recherche Invasions Biologiques « *INVABIO* » lancé en 2000 par le Ministère Français de l'Environnement, un projet a été retenu pour La Réunion. Il a démarré en 2002 pour une durée de trois ans. Il est piloté par l'*Université de La Réunion* et le *Conservatoire Botanique National de Mascarin*, avec l'implication de l'*Office National des Forêts de La Réunion*, en tant que gestionnaire des milieux naturels de l'île. Ce projet a une dimension régionale avec la collaboration de l'*Université de Maurice*, à travers la collaboration de V. Florens, spécialiste de la malacofaune terrestre des Mascareignes. Ce projet est financé par l'Union Européenne (FEDER), le Conseil Régional de La Réunion et l'Etat français (Ministère de l'Ecologie et du Développement Durable). Ce projet s'intitule « *Invasion par les plantes exotiques dans une île océanique : impact écologique à La Réunion et valeur patrimoniale des écosystèmes indigènes envahis* ».

L'objectif de recherche est de mesurer l'impact de la lutte mécanique sur la biodiversité indigène et la dynamique des communautés indigènes. Le suivi scientifique des opérations de contrôle de plantes envahissantes réalisées par l'ONF est en cours sur un dispositif expérimental installé dans la Forêt de Bon Accueil (Réserve Biologique Dirigée des Makes).

Expérimentations réalisées en 2002 : impact deux ans après éradication

En 2000-2001, le Longose de Gardner *Hedygium gardnerianum* (Zingiberaceae) a été éradiqué par l'*Office National des Forêts* dans une forêt humide de moyenne altitude située dans la Forêt de Bon Accueil. Deux ans après l'éradication, l'abondance et la richesse spécifique des plantules d'espèces ligneuses, des herbacées, et de la microfaune du sol ont été mesurées sur 100 quadrats de 1 m² (50 quadrats traités et 50 quadrats non traités). Le PAR (Radiation Photosynthétiquement Active) a été mesuré simultanément au-dessus et au-dessous de la strate à *H. gardnerianum*. La banque de graines présente au niveau du sol a également été étudiée.

Les résultats préliminaires sont les suivants :

- L'abondance (nombre d'individus présents) des espèces graminoides indigènes (Poacées et Cyperacées) et des espèces exotiques est plus importante dans les zones où *H. gardnerianum* a été éradiqué.
- La richesse spécifique (nombre d'espèces présentes) est plus importante dans la zone éradiquée. Les espèces pionnières indigènes sont plus abondantes dans les zones traitées (*Aphloia theiformis*, *Claoxylon* spp., *Dombeya* spp., *Phyllanthus phillyreifolius*).
- L'éradication de *Hedychium gardnerianum* a entraîné une augmentation de l'abondance des espèces exotiques ligneuses et herbacées (*Ardisia crenata*, *Litsea glutinosa*, *Psidium cattleianum*, *Solanum mauritianum*, *Boehmeria macrophylla*, *Duchesnea indica* et *Geranium robertianum*).
- Parmi les graines présentes dans la banque de graines du sol, les graines des espèces exotiques sont plus nombreuses dans les zones éradiquées.
- Parmi les invertébrés présents sur le site, les mollusques terrestres sont bien représentés avec 6 espèces indigènes (dont une espèce de limace endémique) et 5 espèces introduites.
- La strate à *H. gardnerianum* absorbe 85-95 % du flux lumineux qui arrive au sol.

Les mollusques ont été choisis comme groupe bio indicateur. Les mollusques terrestres constituent un compartiment essentiel de la biodiversité animale dans les îles océaniques avec 87 % des espèces endémiques des Mascareignes (Griffiths 1987).

Expérimentations en cours : suivis de l'impact avant et après un contrôle mécanique

Le contrôle mécanique de *H. gardnerianum* a deux impacts principaux : i) accroissement de la lumière disponible au niveau du sol (coupes des tiges) et ii) perturbations au niveau du sol (arrachage des rhizomes). Afin de distinguer l'impact de chacune de ces perturbations, les quatre traitements suivants ont été appliqués (3 répétitions par traitement; 12 placettes de 200 m² au total) :

- 1 – arrachage des rhizomes → accroissement de la lumière et sol perturbé,
- 2 – coupe des tiges → accroissement de la lumière et sol non perturbé,
- 3 – arrachage des rhizomes + installation d'ombrières → ombre et sol perturbé,
- 4 – aucun traitement (témoin) → ombre et sol non perturbé.

Pour ces quatre traitements, les paramètres suivants ont été mesurés avant et après traitement :

- Abondance et richesse spécifique des plantules d'espèces ligneuses et des herbacées,
- Abondance et richesse spécifique des mollusques terrestres (escargots et limaces),
- Mortalité des plantules d'espèces indigènes ligneuses,
- Croissance de deux espèces endémiques dominantes du sous-bois (*Chassalia corallioides* et *Gaertnera vaginata*),
- Germination de 2 espèces exotiques (*Ardisia crenata* et *Hedychium gardnerianum*), et de 3 espèces indigènes (*Aphloia theiformis*, *Antirhea borbonica* et *Geniostoma borbonicum*),

- *PAR*, humidité et température au niveau du sol avec ou sans la strate à *H. gardnerianum*,
- Vitesse de la décomposition de la litière.

Discussion et conclusion : difficultés, retombées et perspectives

Les résultats de ce programme de recherche sont prévus pour la fin de l'année 2004 et pourront servir de référence pour le contrôle des plantes exotiques et la restauration des écosystèmes terrestres indigènes envahis.

Difficultés

Certaines difficultés rencontrées au cours du projet peuvent déjà être identifiées :

- Le suivi expérimental de l'impact de l'éradication d'une plante envahissante est coûteux, long à mettre en œuvre et nécessite une présence humaine régulière et continue sur le terrain.
- Les effets doivent être suivis sur du long terme. Le pas de temps étudié va être important pour l'interprétation des résultats. L'impact après six mois et après deux ans ne sera pas le mêmes.
- Le choix des variables indicatrices de l'impact est délicat car les réponses biologiques sont variables à l'intérieur d'un écosystème indigène et ne sont pas toutes significatives pour mesurer un impact. La difficulté est de choisir les variables qui permettent de mesurer des effets positifs ou négatifs de l'éradication.

Retombées pour la conservation

Les résultats attendus auront des retombées pour la conservation des écosystèmes indigènes de l'île :

- l'approche expérimentale du projet *INVABIO* permet de suivre directement sur le terrain l'impact d'une éradication à l'échelle d'un écosystème forestier indigène ;
- On devrait pouvoir également mesurer le niveau de sensibilité des habitats indigènes aux invasions et aux interventions de contrôle de l'envahissement ;
- le suivi de l'impact des différents traitements va permettre d'identifier les facteurs qui favorisent ou qui limitent les invasions.

Retombées pour les gestionnaires des milieux naturels

Les résultats de ce projet de recherche devraient avoir des retombées pour les gestionnaires des milieux naturels :

- l'identification des indicateurs de l'impact d'une plante exotique envahissante et de son élimination couplée à la restauration écologique aidera à faire des évaluations pour les décideurs ;
- cette expérience de suivi scientifique de l'impact va permettre d'évaluer le coût et les bénéfices engendrés d'un point de vue écologique et économique ;
- les résultats obtenus serviront à mettre au point une méthode générale de contrôle des plantes exotiques envahissantes et de restauration des habitats les plus menacés.

Retombées pour La Réunion sont importantes

Ce projet a permis de créer de nombreux partenariats et des liens entre les institutions : l'Université de La Réunion, le Conservatoire Botanique National de Mascarin, l'Office National des Forêts, le Pôle de Protection des Plantes (DAF/SPV, CIRAD), la Mission

Parc National des Hauts, le Conseil Régional, le Conseil Général, et certaines îles voisines comme Maurice et les Seychelles. Ce projet de recherche a donc créé une dynamique locale importante entre les différents acteurs de la Conservation.

A l'initiative de la DIREN-Réunion (Ministère de l'Environnement), un Comité des Invasions Biologiques de La Réunion a été créé récemment. Il regroupe des spécialistes, des scientifiques, des gestionnaires, des décideurs, des éducateurs, mais aussi des associations, professionnels de l'environnement. Il va permettre d'échanger des informations, de coordonner les actions et de mettre au point une stratégie de lutte globale.

Le projet INVABIO est déterminant pour la recherche et la gestion des invasions. Il a permis :

- De poser les questions scientifiques autour de la problématique de l'impact des invasions
- D'orienter les essais expérimentaux en cours en milieu naturel
- D'améliorer la gestion des « *pestes végétales* » : contrôler les invasions et restaurer les habitats les plus menacés.
- D'initier une stratégie de lutte contre les invasions à l'échelle de l'île

Les résultats des recherches peuvent avoir des retombées à plus long terme pour les futurs projets locaux tels que la création d'un Parc National des Hauts.

Le plan régional

Sur le plan régional les perspectives sont nombreuses pour les îles de l'Ouest de l'Océan Indien pour limiter les invasions et maintenir la biodiversité indigène. Un des principaux objectifs à court terme va être de structurer les actions et les études dans la région Ouest de l'Océan Indien.

L'atelier de travail régional organisé par la COI aux Seychelles du 13 au 17 octobre 2003 va permettre de partager les expériences, d'identifier les priorités régionales, définir un programme commun et d'initier un réseau de scientifiques, de gestionnaires et d'acteurs de la conservation entre les îles de l'Ouest de l'Océan Indien.

Le Projet Régional de Protection des Végétaux (PRPV) mis en œuvre par la COI sur financement européen va permettre de mieux contrôler l'entrée des organismes nuisibles aux frontières et la mise en quarantaine. Le PRPV traite les aspects réglementaires, éducatifs, de sensibilisation et d'échange d'information. Il peut servir de modèle pour un programme commun sur le contrôle des plantes exotiques envahissantes à l'échelle régionale.

La coopération régionale est très importante pour résoudre le problème des invasions biologiques dans les îles de l'Ouest de l'Océan Indien. Certains programmes d'échanges sont en cours, en particulier avec :

- Maurice : collaboration scientifique entre le CBNM/Université de La Réunion et l'Université de Maurice dans le cadre du projet *INVABIO* ;

- Mayotte : collaboration au programme de recherche *Écosystèmes Tropicaux* intitulé Interactions entre espèces à Mayotte, variations de la biodiversité et des valeurs patrimoniales perçues. Points de comparaison sur quelques espèces à La Réunion, avec le MNHN, CNRS, EPHE, INALCO et financé par le Ministère de l'Environnement ;
- Seychelles : contribution réunionnaise à l'étude sur les espèces ligneuses envahissantes des îles de l'Ouest de l'Océan Indien menée par la FAO et le Ministère de l'Environnement des Seychelles ;
- Afrique du Sud : programme de recherche sur l'analyse spatiale et quantitative de la transformation des milieux naturels de l'île de La Réunion avec l'*Institute for Plant Conservation* et l'Université de La Réunion et financé par le Ministère des Affaires Etrangères.

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Restauration écologique à l'île de La Réunion

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Résumé

Depuis les années 1980, des opérations de restauration écologique sont entreprises à La Réunion afin d'assurer la conservation à long terme des écosystèmes indigènes. Concernant une grande diversité de milieux, ces opérations interviennent principalement après des incendies et des travaux de lutte contre les espèces végétales invasives. Excepté quelques initiatives en terrain privé, la majorité de ces opérations a lieu en forêt publique (100 000 ha environ), et en particulier au sein des réserves biologiques et naturelles (35 000 ha environ). Elles sont mises en œuvre principalement par le service forestier local (Office National des Forêts).

Trois exemples d'opérations de restauration écologique sont donnés pour illustrer une partie des actions réalisées à La Réunion. Les deux premiers exposent les travaux réalisés dans deux réserves et le dernier exemple présente une initiative menée en terrain privé par un particulier.

Enfin, une réflexion à l'échelle de l'Océan Indien est engagée à partir de ces exemples. Avec des moyens qui restent limités, il s'agit entre autres, pour le gestionnaire, de bénéficier de l'expérience acquise par chacun des états membres de la COI.

Abstract

Habitat restoration has been undertaken in La Reunion since the 1980's in order to ensure a long-term conservation of native ecosystems. This has been achieved in a great diversity of habitats, mainly after fire or invasive plant eradication. Apart from a few actions conducted on private land, the majority of habitat restoration has taken place in state-owned forests (approximately 100 000 ha), especially in nature and biological reserves (approximately 35 000 ha). These restoration operations have been carried out principally by the local Forest Service (Office National des Forêts).

Three case studies are presented to illustrate some of the actions achieved in Reunion Island: two in reserves and the third one on private land.

The issue of habitat restoration is then considered at a regional scale. With limited resources, it is crucial for the conservation manager to benefit from the experience acquired by all the other member states of the COI.

Introduction

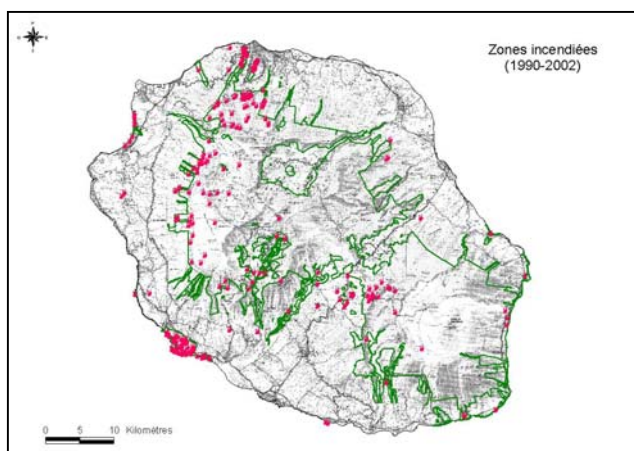
La Réunion fait partie d'un des 25 hot-spots de la biodiversité, avec les îles du Sud-Ouest de l'Océan Indien. La principale menace pour la survie de ces écosystèmes insulaires est l'invasion par les plantes invasives, dont la propagation est souvent facilitée par les animaux introduits.

Face à cela, le service forestier local (ONF), qui gère 100 000 ha de milieux naturels, entreprend, depuis les années 1980, des opérations de restauration écologique pour assurer leur conservation à long terme. Des initiatives ont également été entreprises en terrain privé par des particuliers, en zone semi-sèche. Enfin, depuis deux ans le Conseil Général, qui mène une politique d'acquisition foncière de milieux sensibles en terrain privé, commence à mettre en œuvre, par le biais d'associations, des opérations de restauration des milieux, après éradication d'espèces végétales invasives.

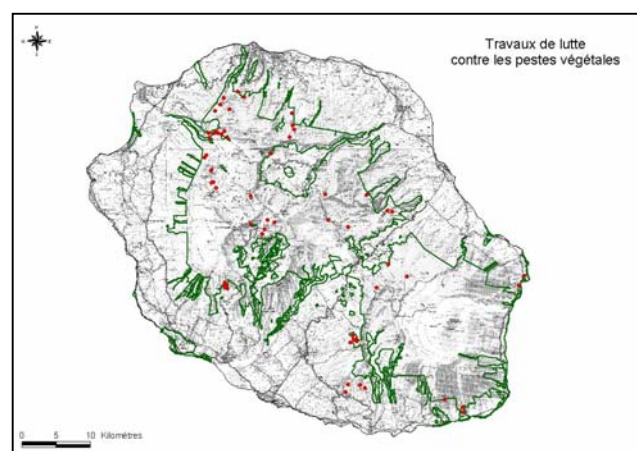
1. Opérations de restauration écologique entreprises à l'échelle de l'île

Les opérations de restauration écologique à La Réunion interviennent principalement après :

- Des incendies (v. carte des incendies)
- Des travaux de lutte contre les espèces végétales invasives (v. carte des travaux de lutte)



Carte n°1 : zones incendiées (1990-2002)



Carte n°2 : zones de lutte contre les pestes végétales

Les opérations entreprises se répartissent sur l'ensemble de l'île et concernent une large gamme de milieux naturels. Mais, elles ont lieu essentiellement dans le domaine forestier (limite verte sur les cartes), et en particulier dans les Réserves Biologiques et Naturelles, où une gestion conservatoire est mise en œuvre pour freiner l'effet des invasions biologiques et restaurer les milieux dégradés.

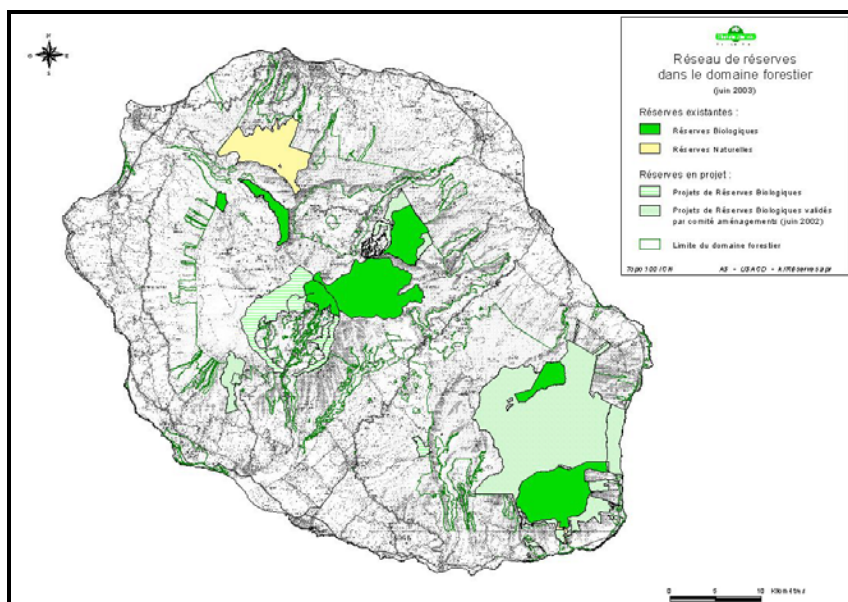
Les tableaux 1.a et 1.b. présentent un état des lieux des réserves à La Réunion en septembre 2003

Type de réserves	Nb	Surface (ha)	%age du domaine relevant du RF	%age de l'île
RBD	3	6 822	6,8%	2,7%
RBI	4	7 062	7%	2,8%
RN	2	3 711	3,7%	1,5%
Total réserves	9	17 595	17,6%	7%

Tableau 1.a. Réserves existantes (RBd = Réserve Biologique dirigée, RBi = Réserve Biologique intégrale, RN = Réserve Naturelle).

Type de réserves	Nb	Surface (ha)	%age du domaine relevant du RF	%age de l'île
RBD	7	7 521	7,5%	3%
RBI	4	24 517	24,5%	9,7%
RN	2	3 711	3,7%	1,5%
Total réserves	13	35 749	35,7%	14,2%

Tableau 1.a. Réserves dont le projet est validé par le comité des réserves



Carte n° 3: Carte du réseau de réserve à la Réunion

Les prochaines créations porteront donc les réserves à plus de 35 % du domaine forestier.

Par contre, sur terrain privé, aucun projet de réserve n'a encore abouti. Il est à noter toutefois la politique du Conseil Général qui acquiert des espaces naturels sensibles à travers une taxe spécifique (TDENS). Enfin, il est important de rappeler, même si cela porte sur des surfaces limitées, des initiatives de particuliers restaurant la végétation indigène présente sur leur terrain (dans la zone semi-sèche, comprenant un grand nombre de plantes rares).

2. Exemples d'opérations de restauration écologique menées dans les réserves

2.1. Le cas de la Réserve Biologique des Makes

Située dans les Hauts de Saint Louis, cette réserve de 900 ha abrite sur un large gradient altitudinal des milieux indigènes très peu perturbés. La majeure partie de la réserve est dédiée à la libre expression des processus évolutifs (808 ha classés en Réserve Biologique intégrale). La partie basse, qui abrite une des dernières reliques de forêt de moyenne altitude dans l'Ouest, est classée en Réserve Biologique dirigée sur 94 ha. L'objectif est de conserver cet habitat et les espèces qui y sont inféodées en y menant des actions spécifiques.

C'est donc dans la RBd que sont réalisées des opérations de restauration écologique depuis une dizaine d'années. Ces opérations consistent à cicatriser les zones où le couvert forestier est rompu par une plantation d'arbres indigènes (principalement *Weinmannia tinctoria*, *Homalium paniculatum* et *Dombeya sp.*) dont les graines ont été récoltées dans la réserve et les plants éduqués dans la pépinière ONF située à proximité. Le but ultime de ces cicatrisations est de favoriser le retour des espèces indigènes à l'intérieur de ces zones.

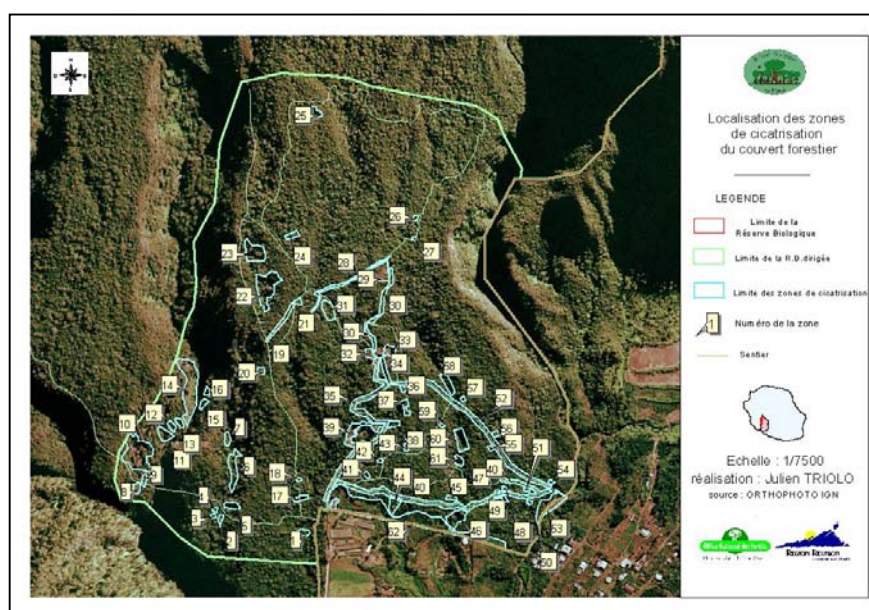
Ces opérations de cicatrisation sont intervenues après:

- Eradication d'espèces végétales invasives (53 zones)
- Rétrécissement de sentiers (7 zones)
- Fermeture d'un sentier (1 zone)
- Défrichage par propriétaire riverain (1 zone)

Au total, plus de 7 ha sont concernés par ces opérations, répartis en 62 zones allant de 50 m² à 12 000 m². Les entretiens réalisées dans ces zones consistent à éradiquer manuellement les espèces exotiques tous les six mois, en veillant à ce que les espèces indigènes ayant réussi à recoloniser la zone ne soit pas endommagées.

Pour permettre une gestion efficace, une cartographie précise des 62 zones a été réalisée (v. carte n°4). Une base de données a également été élaborée : elle renseigne sur la surface de la zone, sur les espèces indigènes plantées et sur les espèces exotiques présentes. Enfin, un panneau spécifique va être implanté cette année sur chaque zone pour en faciliter le suivi.

Pour aider l'agent forestier dans la conduite des opérations de restauration écologique, une liste d'espèces par type de milieu a été élaborée. De plus, des mini-parcelles permanentes de 25 m² ont été inventoriées pour disposer de données quantitatives sur la composition et la structure des 3 milieux forestiers de la réserve. Le suivi dans le temps de ces parcelles (matérialisées sur le terrain) permettra d'avoir une idée de la dynamique de la végétation. 2 programmes de recherche ont également lieu en ce moment dans la réserve et apportent au gestionnaire une aide pour la conduite des opérations de restauration écologique. Le programme INVABIO mené dans la RBd par l'Université et le Conservatoire Botanique National de Mascarin vise à étudier l'impact de différentes méthodes de lutte contre les plantes invasives sur le milieu à restaurer. Le Cirad-forêt a quant à lui implanté une parcelle permanente d'un hectare dans la RBi pour étudier la composition et la structure de la forêt complexe de montagne



Carte n° 4 : localisation des opérations de restauration écologique

2.2. La Réserve Naturelle de la Roche Ecrite

La Réserve Naturelle de la Roche Ecrite (3640 ha) a été créée pour assurer la conservation d'un oiseau rarissime (*Coracina newtoni*), dont la population se situe presque exclusivement dans la réserve.

Dans cette réserve, seules des zones incendiées ont fait l'objet de restauration. Il s'agissait de réimplanter très rapidement sur les crêtes incendiées une végétation indigène, avant que l'érosion condamne définitivement la fertilité de ces sols mis à nu brutalement.

Le plan de gestion, en cours de réalisation, devra déterminer les zones qui bénéficieront d'opérations de restauration écologique.

arrosage) se reproduisent et régénèrent naturellement. En particulier, on constate une très forte régénération d'*Olea lancea*, *Olea europea africana* et *Dombeya acutangula var. palmata*. Certaines espèces très rares montrent également une bonne régénération comme *Croton mauritanus* et *Obetia filicifolia*. Enfin, depuis quelques années, on a pu observer le retour de papillons très rares inféodés à certaines plantes replantées sur le site (*Papilio phorbanta* et *Salamis arguta*).

4. Réflexion pour une stratégie à l'échelle de l'Océan Indien

Quand on réfléchit à une échelle régionale, on peut faire le constat que la Réunion, comme les autres pays de la COI, détermine ces priorités en matière de restauration écologique sans prendre en compte l'état de conservation des milieux des îles qui l'entourent. Pour l'instant, il n'existe pas une stratégie de conservation et de restauration des milieux à l'échelle de l'Océan Indien. De plus, peu de contacts existent pour le moment entre les différents membres de la COI, alors que les problèmes rencontrés sont souvent très similaires (espèces invasives communes, spécificité insulaire, ...) et que chacun pourrait bénéficier du savoir faire acquis par son voisin.

Il est donc important de faire émerger cette stratégie, afin de hiérarchiser au niveau de l'Océan Indien les priorités d'actions et de s'assurer que l'on dispose à l'échelle de la COI d'une politique globale de maintien de la diversité biologique à long terme. Cette stratégie pourra ensuite être déclinée en moyens et en actions dans chacune des îles ou états de la zone Océan Indien.

Plusieurs propositions peuvent être émises pour parvenir à ce but :

- Elaborer une typologie commune des habitats à tous les membres de la COI
- Réaliser une carte des habitats à l'échelle de l'Océan Indien
- Déterminer à l'échelle de la COI les habitats devant bénéficier en priorité de restauration écologique
- Proposer au niveau de chaque membre de la COI des priorités d'actions en terme de restauration écologique, cohérentes avec la stratégie régionale ...

Il est primordial également que les différents membres de la COI puissent se rencontrer régulièrement pour échanger les savoir-faire et expériences acquis. Les ateliers demeurent un bon moyen pour parvenir à cet objectif. Ils permettent de tisser un réseau d'experts sur les différents thèmes touchant la conservation de la biodiversité. L'idéal serait que ces ateliers aient lieu tous les deux ou trois ans, et qu'il puissent se dérouler à chaque fois dans un pays différent.

Conclusion - Perspectives

Les gestionnaires de milieux naturels à La Réunion, et en particulier le service forestier local qui gère la grande partie du patrimoine naturel, sont résolument engagés dans la restauration écologique des milieux indigènes. Mais les moyens demeurent limités et il serait dommage de ne pas bénéficier de l'expérience acquise par chacun de membres de la COI.

L'émergence d'une stratégie régionale permettrait d'orienter efficacement les gestionnaires de milieux naturels dans le choix des milieux à restaurer. Les échanges d'expériences permettront également de rendre de plus en plus efficace les différentes opérations de restauration écologique entreprises. Les rencontres à travers des ateliers demeurent un bon moyen pour que les différents acteurs puissent échanger leur point de vue sur les problématiques et techniques liées à la conservation et la restauration de milieux.

An overview of invasive species issues and management of invasive species for biodiversity conservation in Mauritius

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Abstract

The flora of Mauritius consists of about 700 species of native flowering plants out of which 311 are endemic. Many plants and animals have been introduced to the country since it was first occupied. Many of these exotics specially the plant species have established very successfully in the country such that they are out competing our native plants in the forest. Many *in-situ* and *ex-situ* conservation measures have been initiated to preserve our rich forest genetic resources and also to combat the proliferation of IAS in our forest and islets. However, a great deal still remains to be done.

Key words: Invasive Alien Species, *ex-situ* conservation, *in-situ* conservation”, threatened species, native forest

Introduction

Country background

The island of Mauritius, the largest island in the Republic of Mauritius, is located at latitude 20⁰ South and longitude 58⁰ East, some 900 km east of Madagascar in the Indian Ocean. Mauritius became independent on the 12th March 1968 and became a Republic on 12th March 1992.

Mauritius is of volcanic origin and encircled by fringing coral reefs enclosing lagoons of various widths. The total land area of the islands of the Republic is 2,040 km². Its population is about 1.2 million.

The tropical climate, geology and topographical regimes over million of years of isolation and adaptation have resulted in the evolution of diverse biota with high degree of endemism. However, with human settlement and interference, the history of small island developing states is unfortunately often characterised by extensive habitat degradation and high rates of species extinction.

History

Before its discovery by the Portuguese in 1507, Mauritius was not inhabited by man or any predatory mammals. This resulted in the evolution of flightless birds and defenseless reptiles in dense luxuriant forest.

During Dutch occupation in the 17th century, forests of the lowland regions and the plains were selectively logged. Many of the native ebony trees and palms were cut down.

During French and British occupation, clearing process continued to make place for agriculture (notably sugar cane) as well as infrastructure.

The outcome is such that this island, which used to support a very rich diversity of wildlife is now sadly famous as the home of the extinct flightless dodo, the very symbol of extinction.

Richness

Mauritius has a very high diversity of endemic flora and fauna per unit area. Of the c.700 species of native flowering plants in Mauritius 311 are strict endemics. A high proportion of the endemics (about 40%) are Threatened or Endangered according to IUCN (World Conservation Union) criteria. The main cause of threat is Invasive Alien Species (IAS). In 1984 the IUCN rated Mauritius third in the world after Hawaii and Canary Islands in terms of numbers of threatened plant species (IUCN/WWF, 1984). A large proportion of the threatened plant species survive as tiny populations that have a very high probability of imminent extinction.

Threats to native forests

Damage to native vegetation by Invasive Alien Species

IAS are the biggest threat to the native forests and one of the major causes for extinction of endemic species. Many of these species form monospecific stands, thereby enhancing the risk of erosion. Without doubt the invasive species are in competition with the native plants for food, light, space; consequently hampering the natural regeneration of the natives. A number of the most notable/ troublesome exotic plant species have been identified (Table 1.). Possibly the most problematic species of invasive plant in Mauritius is Chinese Guava (*Psidium cattleianum*), which was introduced during the French era.

Introduced animals, notably Javan or Rusa deer (*Cervus timorensis*), pigs (*Sus scrofa*), monkeys (*Macaca fascicularis*) and rats (*Rattus* spp.) cause direct damage to the native vegetation and both direct and indirect damage to the fauna (Table 2.). However, the exact nature of the effects of these agents on forest dynamics is not clear and needs to be further studied.

Scientific name	Common name
<i>Cervus timorensis</i>	Deer
<i>Sus scrofa</i>	Pig
<i>Macaca fascicularis</i>	Monkey
<i>Rattus rattus</i>	Black rat
<i>Rattus norvegicus</i>	Brown rat
<i>Tenrec ecaudatus</i>	Tenrec
<i>Lepus nigricollis</i>	Hare
<i>Pycnonotus jocosus</i>	Red whiskered bulbul
<i>Achatina fulica</i>	Giant African snail
<i>Oryctolagus cuniculus</i>	Rabbit

Table 1. Some of the harmful animals introduced to Mauritius

Scientific name	Common name
<i>Psidium cattleianum</i>	Chinese guava
<i>Ligustrum robustum</i> subsp. <i>walkeri</i>	Privet
<i>Hiptage benghalensis</i>	Liane cerf
<i>Lantana camara</i>	Vielle fille
<i>Ardisia crenata</i>	Arbre de Noel
<i>Camellia sinensis</i>	Tea
<i>Desmanthus virgatus</i>	Petit acacia
<i>Leucaena leucocephala</i>	False acacia
<i>Litsea monopetala</i>	Bois d'oiseaux
<i>Ravenala madagascariensis</i>	Travellers palm or ravenale
<i>Homalanthus populifolius</i>	
<i>Pinus</i> spp.	Pine
<i>Rubus alceifolius</i>	Wild raspberry or piquant loulou
<i>Rubus rosifolius</i>	Wild raspberry or framboise marron
<i>Syzygium jambos</i>	Rose apple or jamrosa
<i>Wikstroemia indica</i>	Herbe tourtrelle or native rope

Table 2. Some of the most invasive plant species occurring in the native forests of Mauritius

Conservation measures taken by the Government of Mauritius

In-situ conservation

16 Nature Reserves have been declared to prevent any further exploitation. The Black River Gorges National Park, the first National Park in Mauritius, was proclaimed under the Wildlife and National Parks Act 1993. The boundaries of the park enclose an area of 6754ha. A Management Plan for the park has been prepared and published.

Conservation Management Areas (CMAs)

10 CMAs have been set up in Black River Gorges National Park. These are fenced against deer with rocks placed along the base of the fences to keep pigs out. The weeds are manually removed and weeding is carried out at regularly. This slows down degradation of the native forests and allows the natural regeneration of endemic plants.

The endemic birds like the Pink Pigeon (*Columba mayeri*) and Echo parakeet (*Psittacula eques echo*) are also using these sites for nesting and foraging.

However, the setting up and management of these CMAs is very costly and labour intensive.

Management of offshore islets

With regards to management of offshore islets, most of the conservation and restoration works are on Round Island and Ile aux Aigrettes. An Islets Management Plan is currently being prepared. This will cater for some of the other islets.

Ex-situ conservation

Setting up of a Native Plant Propagation Centre (NPPC)

A high proportion of the endemics (40%) are considered as endangered and for 51 taxa, 10 or less individuals are found in the wild. At the NPPC, about 20 out of the 51 taxa have been successfully propagated.

Barkly Tissue Culture Lab

This laboratory is involved in the micro propagation of 15 Rare and Critically Endangered orchids.

Botanical gardens

Five Botanical gardens exist in Mauritius. Some harbour good collections of native plants. The National Parks and Conservation Service has also set up an arboretum at NPPC.

Ongoing Flora and Fauna conservation activities

The restoration of highly degraded and threatened native forests in Mauritius.

The objective of this project is to come up with a method to halt the degradation of the native forests caused by exotic weeds and animals and to restore to the extent possible the original structure and functions of the forest ecosystem. Use of herbicides for weed control has also been experimented with.

Diversity and Conservation of wild population of Mascarene Coffea species

The main aim of the project was to develop a sound conservation strategy based on an assessment of variability present in wild *Coffea* taxa at the genetic and taxonomic level.

Mauritius Rare Fern Project

This project was funded by the UK government under the “ Darwin Initiative for the survival of Species”. The project consisted of developing horticultural facilities for propagating rare ferns in Mauritius, to train Mauritian nationals in fern propagation techniques and to reintroduce rare species of ferns back to suitable managed habitat.

Indian Ocean Commission Project (PRE/COI)

This project falls under the “Programme Régionale Environment” whose objective is to have an integrated coastal zone management + restoration of natural vegetation and removal of exotic species. Under this project the “Morne Sèche Conservation Management Area” has been established. The IOC also funded the compilation of the remaining fascicules of the “Flore des Mascareignes”.

International Conventions and Agreements

In recognition of its unique biodiversity and challenges that it faces, Mauritius was the first country in the world to ratify the convention on Biological Diversity in 1992. Mauritius has also signed many other conventions like Ramsar Conventions and CITES.

Creation of National Parks and Conservation Service (NPCS)

NPCS was established on May 1994 under the Wildlife and National Park Act 1993. It is responsible for monitoring all issues related to the conservation of terrestrial flora and fauna in Mauritius. NPCS is also working in close collaboration with other government sectors like the Mauritius Forestry Service, Barkly Tissue Culture Lab and Non Government Institutions like the Mauritian Wildlife Foundation (Mauremootoo this volume), University of Mauritius (Florens this volume), Mauritius Sugar Industries Research Institution and many other organisations.

Establishment of a National Invasive Alien Species Committee

The Global Invasive Species Programme (GISP) regional workshop for Southern Africa was held in Lusaka Zambia in June 2002. One of the key recommendations of the workshop was the establishment of national IAS working groups or committees. The National IAS Committee for Mauritius was first convened in August 2003. The group meets under the auspices of the NPCS but is chaired by a representative of an NGO. The IAS Committee contains representatives of government, NGOs and the private sector and a diverse range of stakeholders related to agriculture, health, biodiversity, tourism and trade issues. The initial aim of the committee is to foster awareness of IAS issues in Mauritian society as a whole. In the longer term it hopes to help to produce a national IAS strategy for Mauritius.

Gaps and issues

- Lack of resources – both human and financial
- Inadequate legislation for protecting biodiversity on privately owned forests
- Insufficient public sensitization and awareness
- Inadequate knowledge and research in certain areas: Although the threats to biodiversity are known, cost-effective management methods need further research
- Absence of biodiversity emergency response plan.
- Inadequate capacity building

Conclusion

Although conservation activities began some 30 years ago with the implementation of species recovery programmes for threatened bird and plant species as well as habitat restoration, a great deal of in-situ and ex-situ conservation efforts are being and still remain to be carried out to restore, conserve and manage the native flora, fauna and aquatic biodiversity resources of Mauritius.

The war against IAS needs to be fought by all stakeholders as a unit and not in isolation. As part of this collaborative effort there is a need for regional and international cooperation to share knowledge to combat the problem of IAS.

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Research undertaken at the University of Mauritius of relevance to the management of alien invasive species for the restoration of biodiversity

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Abstract

Since 1996, the University of Mauritius undertakes small research projects dealing with various aspects of the problem posed by invasive alien species (IAS) in native terrestrial ecosystems of Mauritius and Rodrigues. Most of these projects are carried out by undergraduate students during their final year of studies. Their research is usually designed and supervised by an academic staff of the University or by an external co-supervisor from bodies such as the Mauritius Sugar Industry Research Institute (MSIRI) or the Mauritian Wildlife Foundation. These research projects focus for the most part on the effects that *in-situ* conservation management, which itself overwhelmingly consists of alien species control, have on various components of the forest ecosystems. Many of the 27 projects to date involved comparing species diversity, density or native plant regeneration between managed and non-managed areas of native forest in order to determine whether the applied conservation actions are reaching their objectives of restoring native populations. Apart from BSc final year studies, a few other research projects also exist that focus on IAS. One of these projects, which is funded by the British Ecological Society, aims to distinguish the major determinants of alien driven forest degradation in Mauritian upland forest remnants and quantify the relationship between degrees of weed invasion and native biodiversity. Another research project in collaboration with the Conservatoire Botanique National de Mascarin and the Université de la Réunion is ongoing and aims at studying the impacts of controlling the invasive plant *Hedychium gardnerianum* in a forest remnant in Réunion. Finally there are currently two other projects studying the interactions between invasive alien species and two threatened endemic trees the *Trochetia parviflora* and the *Sideroxylon grandiflorum*. These two projects are carried out in collaboration with the Mauritius Herbarium at the MSIRI.

Résumé

Depuis 1996, l'Université de Maurice entreprend de petits travaux de recherche sur divers aspects des problèmes causés par les espèces introduites envahissantes dans les écosystèmes terrestres de l'Île Maurice et de Rodrigues. La plupart de ces travaux de recherches sont entrepris par des étudiants en licence dans leurs dernière année d'étude. Ces travaux sont généralement conçus et supervisé par un chargé de cours de l'Université ou par un co-superviseur externe venant d'autres institutions ou organisations tel que le Mauritius Sugar Industry Research Institute (MSIRI) ou le Mauritian Wildlife Foundation. Ces travaux de recherches se focalisent pour la plupart sur les impactes des mesures de conservation, qui consistent principalement du contrôle des espèces envahissantes, sur les differents composants de l'écosystème forestier. Un grand nombre

des 27 travaux de recherches entrepris jusqu'à ce jour ont eu pour objectif la comparaison de la diversité en espèces, de la densité ou de la régénération des plantes indigènes entre les parcelles de forêts avec ou sans gestion de conservation, ceci afin de déterminer à quel point les actions entreprises sont bénéfiques à la restauration des populations indigènes. Hormis ces études, quelques autres travaux de recherches sur les espèces invasives existent aussi. L'un de ces travaux, qui est financé par le British Ecological Society, a pour objectif de déterminer les facteurs les plus importants dans la dégradation des forêts indigènes par les espèces invasives, et de quantifier la relation entre le degré d'invasion par les plantes envahissantes et la biodiversité indigène. Une autre étude en collaboration avec le Conservatoire Botanique National de Mascarin et L'Université de la Réunion vise à déterminer l'impacte du contrôle de la plante envahissante *Hedychium gardnerianum* dans un reste de forêt indigènes à la Réunion. Enfin, il existe aussi deux autres travaux de recherches étudiant les interactions entre les espèces introduites envahissantes et deux espèces d'arbre endémique de l'Île Maurice, notamment le *Trochetia parviflora* et le *Sideroxylon grandiflorum*. Ces deux travaux se font en collaboration avec le Mauritius Herbarium du MSIRI.

Background

The University of Mauritius has a small department of Biological Sciences comprising ten permanent academic staff, only one of which specializes in ecology and conservation of terrestrial ecosystems. Besides, invasive alien species (IAS) constitutes only one of the many topics covered in ecology and conservation of terrestrial ecosystems at the department. There has also been relatively little continuity in research on invasive alien species over the last decade or so given that the holder of this position has changed several times since the mid 1990's. Ever since 1996, the University of Mauritius has regularly undertaken small research projects dealing directly or indirectly with various aspects of the problem posed by IAS in native terrestrial ecosystems of Mauritius and Rodrigues, although the latter has been the theater of far fewer of these projects. Most of these research projects are carried out by undergraduate students during their final year of studies when they have to submit an original piece of research as partial fulfillment for their degree. These projects must be completed within nine months of the onset in August each year till submission date in April the following year. However the students must also follow lectures and sit for examinations during that period such that the actual time devoted to their research projects equates to between 30 and 40% of their time, an equivalent of up to a maximum of about 4 solid months in all. BSc final year projects are thus short projects ideal for punctual studies of small scope and usually unsuitable for any longer term research such as monitoring work.

Undergraduate research projects

From 1996 to 2003, 24 BSc projects have dealt to varying degrees with the various aspects of invasive alien species, giving an average of three per year. Another three projects are currently underway and should be completed in April 2004. BSc final year projects are usually designed and supervised by a member of academic staff of the University and/or by external co-supervisors from research institutes such as the Mauritius Sugar Industry Research Institute (MSIRI) or NGO's like the Mauritian Wildlife Foundation with which the University collaborates very closely when it comes

to supervision of BSc final year projects. Indeed the vast majority of projects have involved co-supervision from a MWF scientist. Many of the BSc final year research projects focused on the effects that *in-situ* conservation management, in particular the weeding of exotic weeds and the fencing out of large alien vertebrates, have on various components of the native forest ecosystems. Groups that have been studied are alien and native gastropods (Florens, 1996), native trees (Ghoorbin 1997), endemic *Phelsuma* geckos (Padayatchy 1998), canopy insects (Budullah 2002), native seedlings (Eydatoulah 1999) and ground insects (Jhumka 2003). Some other recent projects included for example:

- 1) An investigation of the effects that weeding alien plants has on fruit productivity of a major canopy species (Auchoybur 2003)
- 2) The impact of a secondarily invading weed on native plant regeneration within conservation management areas (CMAs) (Muty 2003)
- 3) The determinants of re-infestation rates of woody invasive species into CMAs (Gunessee 2003)
- 4) An investigation of the ecological traits of native trees that exacerbates their susceptibility to invading weeds (Ramsing 2003)
- 5) The influence of degrees of invasion on native tree diversity (Ramlugun 2003).

Several of these projects have substantially increased our understanding of both the alien driven degradation process and the impacts that well-intentioned conservation management is having on the native biodiversity. Unfortunately however, most of these works remain largely inaccessible to the larger community with few having made the object of further publication (Florens *et al.* 1998, Mauremootoo 1997).

Additional research projects

Apart from BSc final year studies, a few other research projects also exist that focus on IAS. The main current project is one funded by the British Ecological Society, and entitled 'Determinants of degradation rates in Mauritian remnant forests and impacts on native biodiversity'. This 18 months long project which is due to end in October 2004 aims at distinguishing the major determinants of alien driven forest degradation in Mauritian upland forest remnants and to quantify the relationship between the various degrees of weed invasion (*sensu* Page and D'Argent 1997) and native biodiversity as indicated by native trees and land snails, two commonly used indicator groups. This project also funds a research assistant to help the project leader bringing the staff currently working on IAS-related project at the University to two persons. Another research project in collaboration with the Conservatoire Botanique National de Mascarin and the Université de la Réunion is ongoing and aims at studying the impacts of controlling the invasive plant *Hedychium gardnerianum* (Zingiberaceae) in the forest of Bon Accueil in Réunion. Further details on this project are provided by Lavergne in these proceedings. Finally there are currently two other projects studying the interactions between invasive alien species and two selected threatened endemic trees. These two projects are carried out in collaboration with the Mauritius Herbarium at the MSIRI. The first one, which started in July 2001 studies the threats besetting the wild population of *Trochetia parviflora* (Sterculiaceae), a species which had been thought extinct until its rediscovery in 2001, 138 years after it was last seen. Besides important depredation of its

fruits by rats and monkeys, which requires bagging the fruits for protection, it was found that the tree seems to be regenerating increasingly towards steeper slopes (Florens *et al.* 2001), a shift apparently brought about by invasive weeds that thrive better in the deeper soils of flatter slopes. While the wild population is still quite large with 76 known individuals, the trend described above is matter for concern as the steeper slopes towards which the species is presently being pushed represents not only a drastic reduction in the species habitat but also an area where the plant may be more at risk to episodic natural drought condition that would have more severe effects in these steeper and rockier areas. The second project, which started in October 2001, aims at determining the reasons behind the excessively poor regeneration of the Tambalacoque tree *Sideroxylon grandiflorum* (Sapotaceae) sometimes also called the Dodo-tree following its alleged broken down mutualism with extinct dodos. The dozen or so reasons that had been put forth in attempts to explain the tree's poor regeneration builds up a very complex picture akin to a nightmare scenario for any conservation biologist wishing to work on the conservation of this species. The results of this research are helping to distinguish the significant factors from the myths or what may be called 'biopoesy'. It is now clear that the bottleneck in the regeneration of the tree intervenes before the production of seedlings and is caused overwhelmingly by invasive weeds competition with adult trees and fruit depredation by alien monkeys.

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Conservation work undertaken by the Mauritian Wildlife Foundation: Our history; the secrets of our success and Where do we go from here?

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Abstract

An overview of the work of the Mauritian Wildlife Foundation (MWF) in Mauritius and Rodrigues is presented. MWF is the largest conservation NGO in the Mascarenes and has actively pioneered a great deal of the conservation work that is now going on in the region.

The range of MWF projects that MWF undertakes are presented. These projects cover the following area: species recovery, ecosystem restoration on mainland and islet locations, environmental education, ecotourism and research in areas that support conservation.

The presentation charts the history of the organisation, from small beginnings as a means of channelling foreign funding and expertise into bird species recovery programmes, to a large national NGO working on the range of areas outlined above.

Some of the factors behind MWF's success are articulated as are challenges that the organisation must face up to if it is to continue to provide leadership in conservation in Mauritius and Rodrigues.

The Mauritian Wildlife Foundation (MWF)

MWF is the largest non-government organization in Mauritius. Its mission is to save the endangered endemic animals and plants of Mauritius from extinction. More specifically its objectives (first set out in 1984 and updated 1997) are to:

1. Save threatened Mauritian species through the restoration of entire ecosystems.
2. Seek new information through field research, data management, captive studies and scientific collaboration for direct application to restoration methods and management.
3. Share knowledge gained through restoration programmes with fellow Mauritian and international conservationists.
4. Share the joys and benefits of native wilderness and wildlife with the Mauritian people.
5. Secure the future of Mauritian species through income generation and sound management of human, fiscal and capital resources.

MWF's funding comes entirely from donations and grants with the latter contributing the vast majority of the organisation's revenue. Grants are mainly for specific projects, which makes the organization's work very much project-focused.

A short history of MWF

MWF has existed under its present name only since 1997. However, the work currently undertaken by MWF enjoys a long history. MWF's roots and the work it undertakes go back over thirty years. The following section is a brief chronology of the development of MWF.

- Early 1970s: work begins on Mauritius kestrel and other Mauritian endangered bird species.
- 1979: Jersey Zoo first begins involvement in Mauritius
- 1982: WWF funding for plant conservation work secured (funding continued until 1993).
- 1984: Mauritian Wildlife Appeal Fund (MWAFF) formed. The initial aim of MWAFF was to raise funds within Mauritius for the activities of Jersey Zoo (later to become DWCT – Durrell Wildlife Conservation Trust)
- 1984: MWAFF granted lease of Ile aux Aigrettes
- 1987: Managed vegetation plots created in Mauritius under the WWF programme in collaboration with the Mauritius Forestry Department
- 1994: Mauritius' first National Park created. At the same time the National Park and Conservation Service was created as a body to run the national park and to oversee conservation in Mauritius (see Gopal this volume). Pioneering conservation efforts from the 1970s helped gain support for the establishment of the national park.
- 1996: World Bank GEF funding of \$1.6 million secured by MWF for restoration work on Ile aux Aigrettes, Round Island and Rodrigues. 1997: MWAFF changed to Mauritian Wildlife Foundation in recognition of its evolving role from a fund-raising organisation to one involved in hands-on conservation
- 1997: Rodrigues Community Educator appointed with funding coming from Philadelphia Zoo.
- 2000: Community conservation work in Rodrigues begins following a grant from the UNDP-GEF Small Grants Facility.
- 2000: World Bank GEF Round Island Restoration Project funding of \$750,000 secured.
- 2003: Full time MWF Executive Director appointed.

As the organisation has developed it has meant considerable expansion. In the early 1970s there were about three staff working on conservation projects at any one time. For much of the time staff were entirely expatriate. Now MWF has a staff of about 70 at all levels, c.50 of whom are Mauritians and c.20 expatriate. MWF's annual budget is currently c.\$US750,000

Projects undertaken by MWF

MWF undertakes projects in both Mauritius and Rodrigues. The Mauritian projects are reviewed below. The MWF projects in Rodrigues are listed in this paper and reviewed in more detail in Payendee (this volume). In all cases MWF undertakes projects in collaboration with relevant Government agencies and other key stakeholders. In the case

of Mauritius the main partners are the National Parks and Conservation Service (NPCS) and Forestry Service and in Rodrigues the Rodrigues Forestry Service.

MWF's projects in Mauritius

Mauritius kestrel species recovery programme

Initial international conservation work concentrated on the Mauritius kestrel (*Falco punctatus*), then the most endangered of Mauritius' bird species (Collar and Stuart 1985) and the most endangered falcon in the world (Jones 1983). The kestrel fell to its minimum population in 1974 when there were only four known wild birds including one known breeding pair (Jones 1987).

In 1981, when a concerted captive rearing programme began, the wild population was estimated at 13 birds (Jones 1987). By the end of the 1986-1987 season 30 birds had been reared (Jones and Owadally 1988). In the meantime wild individuals were supplementary fed where possible to increase reproductive success. Large-scale reintroduction began in 1986. At this time a predator control programme of trapping for mongooses (*Herpestes javanicus*) and rats (*Rattus rattus* and *Rattus norvegicus*) around kestrel nests and poisoning around release sites was started. When the reintroduction began the wild kestrel population stood at an estimated 31 birds including 4-10 known pairs.

The release programme was ended after the 1993-94 breeding season when the wild population stood at an estimated 250 birds including nearly 60 breeding pairs. The kestrel population is currently estimated at 500-800 birds (Jones *et al.* 2002).

The species was down-listed from Endangered to vulnerable in the IUCN 2000 Red List of Threatened Species (Hilton-Taylor 2000).

Mauritius pink pigeon species recovery programme

Pink pigeon (*Columba mayeri*) distribution and abundance has declined in parallel with that of the Mauritian native forest. Pink pigeons eventually became restricted to a single population in the south-west of the Mauritius in area that became known as Pigeon Wood (Jones and Owadally 1988).

A captive breeding programme for pink pigeons was initiated in 1976 (Jones 1987). Captive breeding colonies have since been established at over 32 locations around the world (Jeggo and Stewart 1999). 500-600 individuals have been captive reared in Mauritius since 1976. The majority of these have been released in the wild (F. Koenig pers. comm.).

The pink pigeon field programme began in 1987 with releases in Brise Fer, one of the best remaining remnants of native forest in what is now the Black River Gorges National Park. Predator control through trapping and poisoning is carried out around release sites and around the remaining wild population at Pigeon Wood. Supplementary feeding of released and wild birds began in 1989. Birds are also screened for disease and some treatment of diseased squabs and adults has been carried out (Swinerton 2001). All released and wild birds are ringed. Morphometric data are taken when birds are caught for ringing. Breeding and nesting attempts and other behavioural information are recorded.

Pigeon populations increased rapidly up to 1996 reaching nearly 300 birds at five field sites. Since this time the population increase in the wild has been sporadic, with sub-populations showing signs of density dependent mortality (Swinnerton 2001). The pink pigeon captive breeding programme ceased in 1999. The pink pigeon was down-listed from critically endangered (Collar *et al.* 1994) to endangered (Hilton-Taylor 2000). It has not yet been down-listed to vulnerable as if management were to cease this species would once again be highly vulnerable to the forces that previously brought it close to extinction.

Mauritius echo parakeet species recovery programme

From being fairly common in the nineteenth century the echo parakeet (*Psittacula eques*) population was reduced to about 40 birds in the wild by the early 1970s and by 1986 the population declined to around 20 birds (Thorsen *et al.* 1997).

The echo parakeet species recovery programme that began in 1973 was slow to take off. The in situ captive breeding programme was initially fraught with difficulty. With increased knowledge of the echo's biology, resulting from studies of the birds in the wild, captive methods have been continually improved (Watson 2003, Plant 2003); 74 parrots have been released into the wild from 1997 to 2003 (Malham *et al.* 2003).

This captive rearing effort has been supported by active management of wild birds. Following additional international investment since 1990 it has been possible to: locate and intensively monitor nests, control nest predators, provide supplementary food and to harvest excess eggs and young for captive rearing or for fostering to pairs that have failed to rear young (Jones 1999). Techniques have constantly improved and in the 2001 season a nest box that was acceptable to echo parakeets was designed. This will prove very important as large trees with suitable nesting cavities are becoming increasingly rare in Mauritian forests (Mauremootoo *et al.* unpublished data). The wild population in mid 2003 stood at between 164 and 188 birds (Malham *et al.* 2003) with a further 21 in the captive rearing facility (M. Hipolyte pers. comm.).

This species is still classified as critically endangered since until recently it had a tiny population (Hilton-Taylor 2000). If current intensive conservation actions continue it is estimated that a wild population of over 300 birds could be established by 2007 that if maintained, could result in a down-listing to Endangered (IUCN 2002). In the long-term, unless large-scale forest restoration is implemented, the ultimate success of the echo parakeet conservation programme will be limited by lack of suitable habitat.

Mauritius passerine recovery programme

The passerines of Mauritius have not been subject to the intensive conservation efforts that have been undertaken to help save the kestrel, pigeon and parakeet. The main work carried out to date has been population surveys and ecological studies (Cheke 1979, Cheke 1987, Safford 1997 and Nichols 2001). Recently efforts on the Mauritius fody (*Foudia rubra*) have intensified with the undertaking of pilot work on nest protection and captive breeding. It is planned to release fodies to areas from which they have become extinct (R. Switzer pers. comm.).

Mauritius and Rodrigues rare plant species recovery programme

Much of the on-going work on rare plants in Mauritius has been undertaken by government conservation agencies and foreign botanic gardens as well as by MWF. In 1982 funding from WWF Plants Programme funding was secured (with technical support from IUCN) to expand plant and ecosystem conservation activities in Mauritius and Rodrigues. The project continued until early 1993 with several aims: To identify the most endangered plants in Mauritius and Rodrigues; to prioritise those that need ex-situ conservation and to establish weeded and fenced plots in representative samples of the vegetation types of Mauritius. A priority list of the thirty most endangered plant species for Mauritius and top ten for Rodrigues was drawn up by Strahm (1996). To date twenty-one of the Mauritian species and nine of the Rodriguan species from this list have been successfully propagated.

The Mauritius Forestry Service has recently expanded its native plant production. In 2002 planned production was approximately 100,000 individuals of 100 species. Of these ca.90 are threatened species (Forestry Service unpublished data). From 1998-2001 70,000 individuals of 39 species of endangered plants have been propagated on Rodrigues (Mauremootoo and Payendee 2002), 17,000 individuals of 21 species of endangered plants on Ile aux Aigrettes (Victoire unpublished data). The NPCS has propagated 165 species of threatened plants in their native plant nursery (NPCS unpublished data). Many of these species have been reintroduced into managed plots in the Black River Gorges National Park (S. Gopal pers. comm.). Material from some of the rarest plant species in Mauritius and Rodrigues has been taken to botanic gardens abroad for propagation.

Until recently plant species recovery efforts in Mauritius have concentrated on saving the species itself and paid little attention to maximising the conservation of within-species diversity. In Rodrigues the labelling of all founders of species with less than fifty known individuals in the wild and the use of a propagation database has facilitated the collection of propagation material from all wild individuals where possible. The size and lack of major topographic barriers on Rodrigues has probably meant that all individuals of a species constituted a single population until their numbers were fragmented following settlement. Therefore, no efforts are made in Rodrigues to separate the progeny of founders from different locations.

There are reasons to assume that individuals of many species in Mauritius may have been genetically isolated from each other for some time (Mauremootoo et al. in press a). This has led to an approach developed by MWF of establishing area-specific field genebanks. All main stakeholders carrying out rare plant species recovery programmes in Mauritius are now aware of the need to minimise mixing of conspecifics from different regions in order to potentially maximise the conservation of within-species diversity.

In spite of the work carried out on rare plants the flora of Mauritius and Rodrigues remains highly threatened. According to recent revisions using the IUCN categories of threat (IUCN 2001) 94 % of the endemic flora of Mauritius and 100% of the endemic flora of Rodrigues is threatened to some degree (MWF unpublished data)

Restoration of Ile aux Aigrettes

Ile aux Aigrettes is a 26 ha islet, only 750 m from the Mauritian mainland and within the lagoon. When MWF took a lease on the island in 1984, Ile aux Aigrettes was highly invaded by a number of introduced mammals and numerous woody weed species though it still contained Mauritius' best-conserved remnants of coastal ebony forest.

Since the mid-1980s all introduced mammals except the Indian house shrew (*Suncus murinus*) have been eradicated and the island has been subject to an intensive weeding and native replanting programme. From 1985 to mid 2002 approximately 75 man-years of mostly hand-weeding had been carried out on the island and over 50,000 plants had been planted, most since 2000. For details of the history of vegetation management on Ile aux Aigrettes see Newfield *et al.* 2003.

The practically predator-free status of Ile aux Aigrettes has made it a key resource for the reintroduction of endangered plant and animal species as part of an effort to diminish extinction risks (Dulloo *et al.* 1997). 20 endangered plant species have been introduced to the island up to 2003. So far kestrels and pink pigeons have been translocated to Ile aux Aigrettes as part of species recovery programmes. The pigeons have remained on the island with kestrels dispersing to the nearby south-eastern mountains. It is hoped that following the planned eradication of shrews that introductions of some of the endangered species of reptiles currently found only on Round Island can be carried out.

Restoration of Round Island

Round Island is situated c.20 km off the north-east coast of Mauritius, well outside the lagoon. Access to the island by boat is very difficult as the island has a completely rocky shoreline and the sea is usually very rough. This inaccessibility, which has helped to conserve some of its unique biodiversity, has also meant that until recently it has only been possible to undertake conservation activities in brief but intensive bursts of activity. Such activities, however, have in some cases been of great conservation importance.

The eradication of goats in 1979 and rabbits in 1986 was essential for the protection of the remaining biodiversity of Round Island (Hartley 1987). Regular surveys have given us an indication of how the Round Island ecosystem has recovered after the mammal eradications. It is clear that the rabbit and goat eradications were undertaken just in time to save the unique Round Island ecosystem Bullock *et al.* (2002).

Pilot planting work to aid in the restoration of Round Island was undertaken as part of the GEF project from 1996-2001. The scaling up of these activities has been possible thanks to the securing of a Medium Size GEF project for the restoration of Round Island. This grant has funded a permanent presence on the island, where a semi-permanent field station has been constructed. Water catchments have been installed and plants can now be watered after planting as necessary.

Current vegetation restoration plans for Round Island involve creating scattered areas of native woody pioneer species that will in time serve as foci for colonisation of areas currently dominated by non-native herbaceous vegetation (Mauremootoo *et al.* 2001).

The other key element of the management of the Round Island ecosystem is quarantine. The proposed mode of restoration centres on the premise that the restored areas will provide seed sources to restore the remaining areas of the island with the minimum of intervention. This strategy will only succeed if Round Island is kept free of the kind of woody weeds found on many of the other islets and on the Mauritian mainland. It is also imperative not to introduce any alien animals that could disrupt the fragile Round Island ecosystem.

Ile aux Aigrettes ecotourism project

In 1995 MWF officially endorsed ecotourism as a means to raise public awareness, generate income and employment and to contribute towards the sustainable development of Mauritius and Rodrigues. The following year a grant was obtained from the Japan World Exposition Commemorative Fund for the construction of a visitors' Centre on Ile aux Aigrettes. This was completed in 1997. In the same year Ile aux Aigrettes was opened to tourists in 1997. Facilities for tourists have been generally improved over the years. Visitor numbers have steadily increased. Numbers of Mauritian and international visitors to Ile aux Aigrettes increased from 3,940 in 2001 to 4,600 in 2002 (including 2,051 Mauritians) to 6,500 - 7,000 projected for 2003 and 10,000 in 2004 building up to a projected ceiling of 25,000 by 2006/2007. It is hoped that revenue from the ecotour will sustain the work on Ile aux Aigrettes in the long term and also help towards financing some of MWF's other activities.

MWF projects in Rodrigues

The following projects, listed here, are discussed in detail in Payendee (this volume).

- Rodrigues Community Education Programme
- Restoration of two nature reserves
- Community Restoration of three coastal sites
- Community sustainable use of endemic plants in four villages
- Community restoration around three villages
- Rare plant species recovery programme

Other MWF activities

Research and capacity building

In the long term it is essential that local capacity is built if Mauritian conservation is to advance. In early 2003 seven of MWF's Mauritian staff were undergoing further education (at undergraduate, masters and doctoral level). A further six expatriates were undertaking post-graduate research with MWF.

The research projects being undertaken cover a wide range of topics of relevance to MWF's conservation work. They include disease ecology, population genetics, forest dynamics and animal-plant interactions.

Advocacy

Biodiversity conservation has not always been a high priority in Mauritius. The day-to-day activities of MWF have certainly helped to elevate conservation considerations in Mauritius. In addition specific advocacy work undertaken by MWF, has, in many cases helped advance the cause of conservation in Mauritius and Rodrigues. A specific example of the importance of advocacy is illustrated by MWF's reaction to a proposal to

extend the runway of Plaine Corail airport in Rodrigues into the neighbouring Anse Quitor nature reserve. MWF's ability to galvanize high-level international support for an alternative of orienting the runway extension away from the nature reserve was accepted by the authorities after quiet but concerted campaigning.

Public relations

Public relations is a key activity for an organisation such as MWF that needs to raise its own funds and seeks to inform the general public and decision makers about biodiversity conservation. In recognition of this MWF has appointed a public relations manager as one of its senior managers (along with its flora and fauna managers). PR activities include regular media work, development of brochures and posters, donor care and website development.

International conservation work

MWF's core activities are in Mauritius and Rodrigues. However, MWF staff have frequently been called to undertake consultancy work overseas both in islands in the region such as La Réunion, the Comoros Islands, Seychelles and Madagascar and elsewhere including Hawaii, Kenya and Uganda. Such activities could be formalised within a regional project to enhance the sharing of expertise within the region.

Staff exchanges

MWF has recently expanded staff exchanges with other conservation organisations in the region (Nature Seychelles and le Conservatoire Botanique National de Mascarin, Réunion) and abroad (Island Conservation USA and Department of Conservation New Zealand amongst others). Such initiatives are of the type that can be undertaken as part of a regional programme on invasive species management for ecosystem restoration.

The “secrets” of the success of MWF

MWF has enjoyed great successes over the years. Some of the possible reasons for this success are outlined below.

International support

The initiation of the conservation work in Mauritius was only possible thanks to committed International support in the early years and long-term commitments that have continued to this day. The continued support offered by DWCT stands out in this respect.

Support from the Government of Mauritius

International efforts in Mauritius have only been possible because of the fact that the Government of Mauritius has provided a positive enabling environment. Support has generally not been directly financial but has been given in ways such as through the provision of facilities such as field stations, services at reduced prices such as helicopter trips to Round Island, duty free facilities for items such as jeeps and the provision of work permits for foreign staff. In addition day-to-day work relationships between MWF and government counterparts have generally been very positive.

Ability to attract international volunteers

Mauritius is an attractive location for foreigners. This fact, together with the relatively low cost of living compared with the west and the chance to gain valuable experience has meant that MWF projects have always been able to attract expatriates to work either as volunteers or for relatively low salaries. In many cases the main qualification for

volunteers has been enthusiasm but increasingly highly qualified expatriate personnel are being attracted to Mauritius.

Flexibility

A great deal of the work MWF has undertaken has been pioneering. It has, therefore, not been possible to predict the exact effects of any actions undertaken. Flexibility has, therefore, been of key importance in being able to adopt an adaptive management approach. The improvements in techniques adopted in all the bird and plant species recovery and restoration programmes are examples of such a responsive approach. Underpinning all of this is the acknowledgement of the need for flexibility.

Focus

Flexibility should not be confused with a lack of focus and keeping its focus on core activities has been one of the reasons that MWF has been successful over the years. Inevitably there are many worthy projects and causes. There has been a great deal of pressure on the organisation to be involved in such activities that are often outside MWF's core programmes. By and large these demands have not been heeded because of a fear of spreading the competences of the organisation too thinly.

Fundraising

As mentioned MWF has always depended on grants and donations to carry out its activities. The continued funding from DWCT has provided a degree of financial stability for the organisation. Beyond DWCT funding, grants and donations have had to be actively sought, notably (though not exclusively) for the non-fauna projects. MWF has been highly successful in this and projects have enjoyed a degree of continuity even if funding sources have not always been long term.

Institutional challenges

Inevitably there are challenges that must be overcome if the momentum established by MWF is to be maintained in the years to come. Some of these challenges are discussed below:

Coping with expansion

As highlighted previously MWF has expanded considerably over the years. In view of Mauritius' conservation needs this is a good thing. The fact that all conservation needs are far from being met in Mauritius may mean that MWF (or at least in conservation effort in Mauritius as a whole) will have to expand further in the coming years.

While the expansion of MWF has been a good thing for conservation in Mauritius it has not been without its difficulties. Structures and procedures could be fairly informal when MWF was a small organisation. This is not possible when an organisation expands beyond a certain size and coping with expansion is a common challenge for NGOs (Hudson 1999). An increase in size has meant an increase in administration. New procedures and an expanding administration are not the kind of thing that conservationists necessarily take kindly to, especially when they have been used to a more informal environment. The adoption of new structures has the potential for undermining the flexibility, highlighted above as one of MWF's strengths. A balance will need to be found between formalised procedures and flexibility as the organisation expands. Finding a balance that is widely accepted represents a considerable challenge.

Need to adopt ecosystem approach

In spite of MWF's stated objective of saving 'threatened Mauritian species through the restoration of entire ecosystems' the approach adopted so far has rarely integrated all ecosystem elements. The prevailing state has been a separation of the flora and fauna sides of the organisation. This separation may owe something to DWCT's tradition as organisation dedicated exclusively to animal conservation. It is clear, however, that if sustainable populations of many of the endangered animals of Mauritius are to be achieved it will mean that attention must be turned to whole ecosystems. Species-centred approaches are needed for very rare animals and plants but in the long run these approaches will not be sustainable if sufficient suitable habitat is not available. There are positive moves towards integrating flora and fauna projects in MWF. Round Island staff all work on plant, reptile and seabird programmes and research projects on plant-animal interactions have recently been developed.

Need for more awareness and education work

In spite of the achievements of the past three decades the general levels of conservation awareness in Mauritius is very low. MWF's work has historically focused on immediate conservation priorities and not on the long-term work of education and awareness raising. The work of the MWF educator in Rodrigues has shown the value of this approach in encouraging widespread community participation in conservation activities (Payendee this volume).

Rodrigues has a population of only 35,000 while the population of the island of Mauritius is 1.15 million. Clearly it is easier to get the conservation message across to a relatively small population. Currently the NPCS have an education programme but it does not have a full-time member of staff to implement it. A concerted effort in conservation education in Mauritius is needed if the public is to buy in and contribute to the increased efforts that are needed if conservation is to develop on the scale that is needed to make it sustainable. This does not mean that MWF needs to undertake all these activities itself but it must play some part in making sure that they are undertaken.

Over-reliance on short-term international staff

As mentioned, one of the strengths of MWF has been its ability to attract staff from overseas. In many cases international staff are highly experienced and such skills are not always available in Mauritius. In other cases those from overseas are not so experienced but offer their services as volunteers.

However, it is not healthy to be over-reliant on overseas staff who usually only stay in Mauritius for a short period of time. In many cases new arrivals learn the intricacies of the project after several months, become highly productive in the succeeding months and then leave, to be replaced by another expatriate who then goes through the same cycle. This makes continuity difficult.

In the long term the challenge will be to attract more and more Mauritian staff with the role of expatriates diminishing. This is the way that things are now evolving in MWF. However, it would not be sensible to envisage a situation where there are no expatriates working in Mauritian conservation. On a small island there will always be capacity deficiencies in certain areas. In addition having expatriates helps to reinforce Mauritius'

position in an international network from which Mauritians, as well as expatriates, benefit.

Reliance on short term international funding

With the exception of the support given by DWCT and the previous long-term commitment of WWF, all project funding that MWF receives is short term. This puts considerable pressure on project staff. Project managers often have to devote a large amount of their time to looking for new funding sources to replace those that are about to run out. The ability to attract, develop and keep Mauritian staff is often jeopardised by an inability to offer even minimal guarantees of job security and career development.

In addition Mauritius currently finds itself in an awkward situation vis-à-vis international funding. If its development trajectory continues as it has in recent years it is likely that Mauritius will soon no longer meet the eligibility criteria for many donor agencies (Mauremootoo *et al.* in press b). UNESCO for example will be pulling out of Mauritius in 2004. Funds for biodiversity conservation will have to come increasingly from internal sources if conservation donor agencies adopt a similar stance. Decreased eligibility for international funding and the lack of a sustainable source of core funding will put MWF's future in jeopardy unless alternatives are found.

The Future?

Conservation in Mauritius, in which MWF, or its precursors, have played a pivotal role can be characterised as having gone through two stages (Mauremootoo and Towner-Mauremootoo 2003); those of species recovery and small-scale ecosystem restoration. The challenge is moving on to the third stage, that of large-scale ecosystem restoration, which will make conservation sustainable in the long run. This is not a challenge for MWF alone but the entire Mauritian conservation community.

The challenge facing MWF is how to maintain the positive traits that have allowed the organisation to achieve so much to date while at the same time addressing some of the challenges outlined in the previous section. The fact that MWF has grown and developed over thirty years gives one confidence that it can rise to those challenges. If it can it is well placed to lead the conservation agenda. This agenda must place large-scale restoration at its very heart if truly sustainable conservation is to be achieved in Mauritius and Rodrigues.

Acknowledgements

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Restoration Projects in Rodrigues carried out by the Mauritian Wildlife Foundation

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Introduction

Botanical History

In 1708, Francois Leguat described the then uninhabited island of Rodrigues as a paradise whose 'springs never ran dry'. Less than 200 years later Balfour referred to Rodrigues as 'a dry and comparatively barren spot, clothed with weeds.' Direct exploitation and effects of alien species dramatically reduced Rodriguan biodiversity. Only three of seventeen endemic vertebrates now survive. No areas of full canopy native forest remain. All but two of the 37 surviving endemic plant species are threatened to some extent.

MWF in Rodrigues

The history of the Mauritian Wildlife Foundation (MWF) is discussed in Mauremootoo (this volume). MWF (though not yet under this name) began to be active in Rodrigues in 1982 with the inventory work carried out under the WWF project (Mauremootoo this volume). Over the years MWF's work in Rodrigues has grown from rare species recovery to full-scale forest restoration, environmental education and community participation in conservation. In Rodrigues, as in Mauritius, all MWF projects are carried out with the full support and, in many cases, participation of key government agencies. In the case of Rodrigues this is mainly the Rodrigues Forestry Services.

Projects implemented by MWF in Rodrigues

Restoration of Rodriguan Nature Reserves:

Funded by GEF implemented through the World Bank from 1996-2001.

General restoration efforts have been taking place in Rodrigues' two nature reserves, Grande Montagne and Anse Quitor, since 1986 on small scale with the help of volunteers from WWF and the Rodrigues Forestry Services. From 1996 the GEF funded a five year project to restore native forest in both nature reserves. Local groups such as scouts, Lion's Club, Jeune Chambre Economique de Rodrigues and secondary school students are involved in this process as much as possible.

Up to date about 13 ha of native Rodriguan forest in Grande Montagne and 8 ha in Anse Quitor have been planted with native species making these locations the largest contiguous areas under substantially native forest in Rodrigues.

The production of plants for restoration projects in Rodrigues has been made possible by the construction of a native plant nursery. This construction was carried out in 1996 under funding provided by the GEF project.

The nursery has an annual capacity of 75,000 plants. Most plants produced are for the restoration of Grande Montagne and Anse Quitar nature reserves though some are grown for other projects (see below) as well as for endemic gardens for schools, etc. Propagation trials with seeds, by cuttings or by air layering are performed in the nursery together with finding the best media for the different native plant species to thrive. Seedlings are hardened before going out for MWF's various restoration and community projects. Nursery work also focuses on rare plants. The Solitude nursery is also used for training in horticultural techniques for villagers involved in native plant production in backyard and village nurseries and other projects where MWF is working.

Environmental Education

Funded by the Philadelphia Zoo from 1998.

In accordance with its belief that conservation must occur hand-in-hand with education in order to be successful, MWF maintains one full-time environmental educator. The Rodrigues Environmental Education Programme (REEP) targets both primary school children and local communities. Field outings to the nursery, nature reserves, water sources and treatment plants are included in REEP's syllabus where appropriate. In communities, MWF's environmental educator organizes workshops, clean-up days, and question-and-answer sessions. MWF also works with other stakeholders — both government and NGO, to coordinate island-wide awareness-raising projects.

Sustainable Use of Rodriguan Endemic Plants:

Funded by: UNDP/GEF Small Grants Program from 2000-2002.

The aim of the project is to prevent the over-exploitation and possible extinction of a wide range of useful plant species that are endemic to Rodrigues. The project focuses on developing propagation techniques for endemic handicraft and medicinal plant species and involving the user-community in the protection of these species. After a series of training workshops on plant propagation, community members established small backyard nurseries on a few private properties (c.1000 plants each) using seedlings produced in the backyard nurseries or from the MWF nursery. Larger, central community nurseries are plotted and fenced concurrently. With MWF's facilitation, communities devise a management plan for the future. MWF remains available for technical expertise. By providing a reliable, nearby source of plant materials, these measures will contribute to the livelihoods of community members while at the same time safeguarding the populations of many useful plant species endemic to Rodrigues.

Pilot Coastal Restoration Project:

Funded by European Union from 2002-2003.

This project seeks to restore native vegetation in two contrasting coastal plots. As it is the first project of its kind, this work also aims to establish, through experimentation, workable methodologies for future coastal restoration in Rodrigues. Currently, coastal areas in Rodrigues are planted primarily with alien, invasive species, particularly filao *Casuarina equisetifolia*. The replanting of native flora will help in the biodiversity conservation of an endangered plant community, provide a characteristic look to the Rodriguan coastline, which may enhance aesthetic appeal, and contribute to resilience

against cyclones, thereby reducing coastal erosion. With the help of the local community, the plots are fenced, planted, weeded, watered and monitored.

Tree Planting Project

Funded by EU Anti Erosion Programme and the Whitley Laing Foundation from 2003-2004.

The aim of the project is to use native plants for functions such as the provision of windbreaks and to counter soil erosion in the vicinity of Rodriguan fields and villages.

Five sites have been identified for the above project. The project started in June 2003 by site visits to the village nurseries (that were already in existence) and meetings with the villagers who used to manage them to explain the importance of reorganising the village nurseries. All the villagers were given guided tour of the MWF Nursery as well as training in nursery practices. Exchange between nurseries was also organised for personal comments and observations.

Plants produced by the nurseries will be planted by the villagers early next planting season.

Friends of Wildlife Rodrigues

Funded by UNDP/GEF Small Grants Program from 2003-2004.

While not managed by MWF the FWR project is a good example of a project that has been catalysed by MWF's activities on the island. Over the years MWF has been frequently approached by private individuals for services such as the provision of native plants to grow in private gardens, gardening, tree felling and amenity plantation. In many cases MWF have helped but the demand has steadily outstripped MWF's ability to carry out such work, which is beyond its core project areas. In fact this demand is in many ways a testament to the effectiveness of MWF's work in making people aware of the native flora of Rodrigues. At the same time as this demand has grown MWF has been attracting growing numbers of young Rodriguans to help in its restoration projects. In several instances individuals have been volunteering for over two years.

Given funding limitations it has not been possible to offer all of these people full time employment with MWF. An alternative source of income for these young people was the growing of native plants for sale. With the encouragement and help of MWF staff in Rodrigues and Mauritius, FWR was formed as an NGO for the above purpose. In addition FWR provides gardening and landscaping services. A start up grant has enabled the group to establish nursery facilities, acquire transport and to pay for a trainer for a year to help them to develop key skills such as marketing and financial management.

It is hoped the project will be financially self-sustaining and its activities will complement those of MWF in Rodrigues.

Discussion – the past, present and future for MWF Rodrigues

The work of MWF in Rodrigues has come on hugely in the two decades since the WWF work began. In many ways the work in Rodrigues is further advanced than the projects in Mauritius. The staff on the ground are all Rodriguan with their efforts supplemented by those of occasional overseas volunteers and foreign research students. A great deal of work is carried out with the local community and the education work is well established.

However, there are legitimate fears for the sustainability of MWF's work in Rodrigues. The World Bank GEF funding ended in 2001 and since then funding has been relatively small and short term. Projects funding since the World Bank GEF project (with the exception of that from the Philadelphia Zoo for REEP) has been for one or two years only. No restoration projects can be completed in this time so the challenge has been to maintain projects while seeking new funding. Funding agencies are often reluctant to fund existing projects so demand new ventures. Therefore, MWF in Rodrigues has been in a situation in which it has had to undertake new projects while maintaining projects that are no longer funded in a situation where there have been no additional funds to hire new staff. Inevitably this has strained the capacity of MWF in Rodrigues.

The post-GEF projects undertaken by MWF have succeeded because of the commitment of MWF staff and that of volunteers, including the local communities in areas in which projects are implemented. It is to be hoped that substantial and long term funding is soon found for MWF's work in Rodrigues. Without this funding even commitment eventually has its limits. The lack of such funding would be deeply tragic for a team that has achieved so much over the years.

Management Priorities for Seychelles – a Basis for Discussions

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Abstract

The inner islands of Seychelles, which are of continental origin, are some of the oldest oceanic islands in the world. Their flora and fauna have evolved, through tens of millions of years of isolation and wide fluctuations in size, to have a very high level of endemism. More than half of the indigenous plants are endemic. The indigenous flora survives in small inaccessible craggy areas or scattered forests with a high proportion of exotic invasive species. These remnants are of global importance. The challenge for Seychelles with the help of international communities is to stop the decline of the indigenous flora and fauna due to habitat destruction by invasive species, and ultimately to restore examples of predominantly indigenous ecological communities.

The various studies carried out have concluded that one of the most important threats to the native flora of Seychelles is the invasive species. These species are dominant and severely degrade the ecological habitats. One commonly sees a landscape of forested valleys divided by ridges covered with invasive species. Some of the most notorious invasive plant species are *Cinnamomum verum*, *Paraserianthes falcataria*, *Psidium cattleianum*, *Syzygium jambos*, *Dillenia suffruticosa*, *Clidemia hirta* and several others amongst which many species of creepers.

The crucial question now is what can be done to save the remaining, relatively intact indigenous forests. Even in the most inaccessible sites without any direct human interference there is an element of invasive species. The approach of Seychelles to improve biodiversity zones is to focus efforts on sustained management of forest gaps, whether natural or made by clearing the exotics and invasive and restoring with native species.

In the longer term it will be necessary to introduce new legislations so that stricter measures are applied to tackle the problem of invasive plant species. There is a need to address the issue nationally, as well as regionally since the impact of invasive species touches highly on others sectors of the economy.

Introduction

The native flora of Seychelles has been heavily invaded by a wide range of introduced plant species. Most of the invaders have colonised areas of high levels of human disturbance, but a number of them have also been capable of invading undisturbed ecosystems and accordingly threatens many of the endangered indigenous species and habitats with extinctions. Many of these exotics have invaded the forest gaps formed through timber felling or from ornamentals grown in gardens in forested areas and this is thought to have accelerated their invasion.

Carlstrom further states that Island communities are more likely to lose species from invasive exotic plant species than are analogous mainland areas. The exotic species may displace indigenous species through competition, or reduce biodiversity through the altering of the physical environment, increased erosion and perhaps the disruptive effects on nutrient recycling. The survival of many of the indigenous species probably hinges on the active control of the most aggressive alien species and this is where the management priority for invasive plant species in Seychelles lies.

In this article I will not summarise the results of the FAO survey for the Seychelles (Kueffer and Vos this volume) but will interpret it by giving representative examples.

Three types of insights can be expected from the regional survey:

1. New ideas
2. Learning from experiences made by others, and
3. A bird-eye view of the involved issues that allows to set priorities

Learning from the experiences of others will help to avoid mistakes. The setting of priorities assures that energy and resources are invested where it is most efficient.

However, a regional survey cannot provide ready-made solutions for application. Therefore the subtitle of my presentations reads as ‘a basis for discussions’. I present examples but not final answers. At the end of my presentation as well as of today’s presentation we will have time here in the audience to start discussions and to start work towards future solutions of the invasive species problem in the Seychelles.

My presentation is divided into two parts. First, I take a plant-species perspective and discuss the management of single species in parallel to the management steps scheme introduced by Christoph & Pierre in their presentation (Kueffer and Vos this volume) namely:

1. Priority Species for Control Measures
2. Priority Species for Close Monitoring
3. Priority Species for Border Control

I present examples not complete lists of species to illustrate the concepts.

Secondly I will discuss possible milestones for the control of invasive species in the short, mid and long-terms.

Priority species for control measures

This refers to species that should be controlled by mechanical or chemical control in the field, are chosen according to the following three criteria:

1. negative impact on biodiversity
2. feasibility of control (that is abundance and stage of invasion) and
3. visibility

I present several examples.

Bwa Jaune

Alstonia macrophylla or Bwa Jaune is a relatively recent introduction. It has been planted as a forestry tree probably since approximately the 1970s. Bwa Jaune is in a relative early stage of spread and at the moment mainly present in disturbed secondary vegetation but also on Inselbergs and in open native vegetation. Control of bwa jaune is advisable because it is fairly shade-tolerant and has now started to invade closed-canopy forests, because control on Inselbergs and in open native vegetation is probably fairly easy and effective and the visibility of positive results will be high. The control of the few exotic species present on Inselbergs would leave us with a completely native habitat.

An additional consideration is the control of propagule pressure, that is the production of seeds, in the landscape. *Alstonia* is a wind-dispersed tree that produces large amounts of seeds throughout the year. Wind-dispersal is more effective from higher to lower altitudes and from open to closed canopy sites, than vice versa. If *Alstonia* is controlled on the open Inselbergs emerging from the landscape, seed input and thus invasion into closed canopy forest can be considerably reduced.

Albizia

Albizia (Paraserianthes falcataria) is the clearest example of an ecosystem transformer species in the Seychelles. Firstly, *Albizia* is a N-fixing species that alters soil nutrient content. Secondly, *Albizia* has a light open canopy that allows high levels of light to penetrate to the ground. Finally, adult trees of *Albizia* are vulnerable to storms and can easily fall and produce large gaps. Altered soil conditions, high light penetration and increased frequency of gaps may all facilitate further invasions by other exotic species.

The control of *Albizia* has in the past been tried by ring-barking adults. The results were partly promising. Problems with the method were:

- In areas frequently visited by people falling branches of ring-barked trees are a security risk.
- Below dead ring-barked *Albizia* regeneration of *Albizia* juveniles or of other exotic species may be considerable. Follow-up measures may be needed.

Other species

Cinnamon *Cinnamomum verum* was introduced to the Seychelles in 1772 and spread so rapidly that by the end of the 19th century extensive cinnamon forests are said to have existed. It is today the most widely distributed and probably the most numerous of plant in the Seychelles from the sea level to the highest elevations.

Guava *Psidium cattleianum*, a native of Brazil that has adapted rapidly in the Seychelles as a vigorous growing tree.

Jambosa *Syzygium jambos*, a species that tends to replace the naturally occurring forests in river ravines and humid sites.

Faux vatouk *Clidemia hirta* is a comparatively recent introduction but spreading very fast and is also very elastic.

Priority species for close monitoring

These are species that have proved to be invasive in other countries and are already present in the Seychelles. We chose two examples Bwa Rouge Blan and Bwa Zozo. Other examples include *Memecylon caeruleum* or *Ardisia crenata*.

In the FAO report these species are listed as ‘potentially new invasive species’ (Kueffer and Vos this volume).

Bwa Rouge Blan

Bwa Rouge Blan (*Dillenia suffruticosa*) is a relative of the endemic Bwa Rouge (*Dillenia ferruginea*). It has been introduced as an ornamental and is now frequent found in secondary vegetation, for instance along major roads. It starts to naturalise in closed canopy forests, for instance in the Mare aux Cochons area. It can form dense mono-specific stands. No control attempts have been tried so far in the Seychelles.

Bwa Zozo

Bwa Zozo or Bwa Zwazo (*Litsea glutinosa*) is present in secondary vegetation for instance in the north and northeastern part of the island of Mahé and on small islands such as St. Anne or Cerf Island. This species proved to be very invasive in Mayotte, especially in disturbed forests and forest margins. Bwa Zwazo, as the name indicates, is efficiently dispersed by birds. In Mayotte they try to control the species mechanically in areas of high biodiversity.

Priority species for border control

These are species that proved to be very invasive in other countries and are not yet present in the Seychelles. We chose to present two examples from other islands of the Western Indian Ocean. Species from other tropical islands can easily be identified through searches in Internet databases. A prominent example would be *Miconia calvescens* that has devastating negative impacts on oceanic islands in the Pacific Ocean.

Rubus alceifolius

Rubus alceifolius is one of the most problematic woody invasives in the Mascarenes and already present in the IFR Comoros. It invades open areas where it forms impenetrable thickets. *Rubus alceifolius* has a development strategy mid-way between bush and liana.

Ligustrum robustum

In contrast *Ligustrum robustum* is a shade-tolerant shrub and is capable of invading lowland to mountain forest. It is very problematic in the Mascarenes. *Ligustrum* as well as *Rubus alceifolius* were deliberately introduced to the Mascarenes as ornamentals. They are not yet present in the Seychelles.

Short-term Solutions

Specifically we are looking at things that can be set up within the next year. Some possibilities are listed below:

- An Early Detection System should be set up. A monitoring protocol should be defined through which unusual species that are observed in the forest are noted and reported.

- Based on Internet databases or expert mailing lists the species can be identified and it can be determined if immediate action should be undertaken.
- It is very important to target very problematic species immediately. A delayed management response increases costs dramatically and makes eradication impossible. This is illustrated for example by the case of *Clidemia hirta*.
- Three to five priority species should be defined for control. Control should focus on areas of high biodiversity and should target only a few species where capacity is sufficient for a thorough and long-term effort. I already mentioned two woody species: *Albizia* and *Alstonia*. Besides trees there are also problematic non-woody species such as some creepers, which have started to invade protected areas. *Dieffenbachia* is an example of a herb with a rhizome. Some rhizomatous species such as *Hedychium* have proved to be very invasive and difficult to eradicate in the Mascarenes. *Dieffenbachia* spreads from old settlements for instance in the Mare aux Cochons. Further spread should be stopped.
- There are several successful examples of small island restorations in the Seychelles. These efforts should be continued.

Mid-Term Solutions

This has been characterized as things that can be done within the next five years . Possibilities include the following:

- The legislation should be adapted. Under the ‘Breadfruit protection act’ several invasive species are still protected by law. Felling of these trees is forbidden without special permission. This act should be replaced by a new act that targets very problematic invasive species.
- Basic disposal facilities, for instance for burning plant material, are needed at the Country Entry Points.
- A National Committee should be set up where experts and stakeholders can meet and coordinate the management of Invasive Alien Species.
- Especially, Clear-Cut Responsibilities between Agencies should be defined.
- Restoration Pilot Projects in Intermediate and Mountain Forests are needed to extend the positive results achieved in coastal areas to other parts of the island.

Long-Term Solutions

- The vision for the management of invasive species in the long-term (beyond five years) could comprise of, among other measures, the following:
- Solutions to conflicts of interest should be provided. When the interests of different stakeholders interfere, alternative solutions have to be found. Two examples are given here:
 - Exotic species are still used for erosion control in Seychelles. The needs of erosion control and invasive species management collide. The potential of native species for erosion control should be investigated.
 - Most future introductions of exotic species will probably be for ornamentals. Collaboration between the horticulture industry and invasive species managers will be crucial to minimise the risk of the introduction of very problematic invasive.

Vielle IAS Management Priorities for Seychelles

- *Psidium cattleianum* is problematic in all Western Indian Ocean States. By sharing costs a biological control program could be established. In the Seychelles, *Psidium cattleianum* is especially problematic in mountain forests where chemical control has proved to be inefficient. Biological control might be a future solution.
- Even in Mauritius where habitat restoration has a long tradition not more than a few hectares are managed. The restored areas are small and widely dispersed. Fragmentation of small animal and plant populations reduce their value, and constant input of exotic seeds keep weeding costs high. Only a network of restored habitats in the landscape will prove sustainable in the long term.

Ecosystèmes Forestiers des Comores: Biodiversité, principales menaces, perspective de mise en valeur - Le cas de la Forêt du Kartala dans l'île de Ngazidja

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I- GENERALITES

I.1- Présentation des Comores

Situé à l'entrée du canal de Mozambique, à 320 Km du Nord-Ouest de Madagascar et à 380 Km de la côte Ouest africain, l'archipel des Comores est constitué de quatre îles dont : Ngazidja (Grande-Comore), Mwali (Mohéli), Ndzواني (Anjouan) et Maore (Mayotte). En 1995, les trois premiers îles ont accédées à l'indépendance et forment l'actuelle Union des Comores tandis que Maore reste sous l'administration française et continue d'être revendiquée par les gouvernements successifs des Comores.

L'archipel est d'origine volcanique. L'île la plus ancienne (Maore) est apparu il y a plus de 5 millions d'années et l'île la plus jeune (Ngazidja) est plus d'un millions d'années

I.2 - Population – Densité - Taux d'accroissement (*)

	1980		1991		Taux d'accroissement annuel moyen
	Population (Nb d'habitants)	Densité h/km ²	Population (Nb d'habitants)	Densité h/km	
Ngazidja	182 656	159	233 533	203	2,3%
Ndzواني	135 958	321	188 953	446	3,0%
Mwali	16 536	57	24 331	84	3,6%
Total	335 150	179	446 817	244	2,7%

Tableau 1. Évolution de la population par île, densité et taux d'accroissement annuel moyen.

La population active est de 80% d'agriculteurs, cette population redouble tous les 20 ans et le PNB est de 356\$^(*)

^(*)Source : *Stratégie nationale et plan d'action pour la conservation de la diversité biologique* (1998).

I.3- Cadre institutionnelle et juridique de l'environnement aux Comores

I.3.1- Capacité institutionnelle

En 1992 a été effectué le diagnostique sur l'état de l'environnement aux Comores. Cette étude a mise en évidence une riche biodiversité avec un taux d'endémisme assez élevé, faune et flore. Cependant cette richesse demeure peu connue. La littérature sur la diversité biologique est très pauvre et les quelques informations disponibles sont parfois des publications d'intérêts scientifiques non accessibles au grand public. D'autre part cette biodiversité est très menacée de disparition par une forte pression anthropique exercée sur les écosystèmes et une exploitation anarchique souvent par techniques inappropriés des ressources naturelles.

Cette diagnostique a été suivie par l'élaboration et l'adoption d'une *Politique Nationale sur l'Environnement* (PNE), un *Plan d'action Environnementale* (PAE) et récemment par une *Stratégie Nationale et Plan d'Action pour la Conservation de la Diversité Biologique*.

En matières de gestion, de suivi et de recherche en environnement, les Comores disposent des capacités institutionnelles étatiques ou du secteur civil dont.

Secteur gouvernemental

Dans le secteur gouvernemental, les principales institutions sont les suivantes :

La Direction général de l'Environnement

Elle est chargée de la gestion des politiques et des programmes environnementaux ainsi que la mise en oeuvre des plans d'actions. Elle est représentée dans chaque île par un service (ou direction) environnemental. A noter que la quasi-totalité de programmes de gestion de l'environnement au Comores sont financés par la coopération multilatérale dont l'Union Européenne ou le Fond Mondial de l'Environnement sont les principaux bailleurs.

Le Centre National de Documentation et de Recherche Scientifique (CNDRS)

Le CNDRS est la principale institution de recherche scientifique des Comores. Il coordonne les recherches scientifiques et environnementales grâce à ses structures d'accueils constitués par des unités de recherches, des chercheurs et techniciens. Il diffuse l'information à partir de sa revue scientifique *Yamkobe*. Le centre anime des conférences et organise des ateliers de formation d'intérêt environnementale. La bibliothèque nationale et les archives nationales qui sont aussi abrités au CNDRS, sont des outils très sollicités par le public pour accéder à l'information environnementale.

En matière de conservation et d'exposition, le CNDRS abrite un embryon d'herbier national en cours de constitution, le Musée des Comores est aussi une vitrine de la biodiversité des Comores. Le centre développe un partenariat avec des institutions étrangères en vue de développer la recherche, les échanges et le renforcement des ses capacités.

Les associations villageoises et Organisation Non Gouvernementales (ONG)

Depuis le début des années 90, les Comores ont connu l'émergence des associations villageois et ONG oeuvrant pour la protection de l'environnement. Elles se représentent comme suivent :

Association villageoise ou *Comité Ulanga*

Généralement chaque localité dispose d'une structure dénommé *Comité Ulanga* dont les activités sont portés sur la sensibilisation environnementale par l'organisation d'activités ponctuelles visant à mobiliser la participation collective : journées de nettoyage, de reboisement pour des fins de paysage, ramassage d'ordures ménagères et gestion et entretien des plages. Les Comités Ulanga joue le rôle d'interface entre les décideurs et la communauté de base.

Les ONG

Les ONG sont représentés par trois principaux organisation qui se distinguent par rapport aux *Comité Ulanga*

L'Association d'Intervention pour le Développement de l'Environnement (AIDE).

L'AIDE renferme des compétence requise (connaissance et personnes ressources) en matière de gestion de l'environnement côtier et marin. Elle assure le suivi de l'état de santé du récif à partir d'un projet de la Commission de l'Océan Indien (COI) financé par l'Union européenne.

Les Fédération Ulanga

Chaque île est représentée par une Fédération Ulanga qui regroupe les comités Ulanga locales. Les fédérations sont autonomes et travaillent en réseau au niveau national. *L'Ulanga Ngazidja* dispose d'un organe d'information dénommé, *Habari za Ulanga* (Les événements de l'environnement) où sont publiés périodiquement des articles relatives à la gestion de l'environnement.

Action-Comores

Cette ONG, basée essentiellement dans l'île de Ndzواني, est très célèbre par ses inlassables efforts de protection de la Roussette de Livingstoni. Il s'agit d'un mégachioptère, endémique des Comores qu'on ne retrouve que dans les îles de Mohéli et d'Anjouan, menacée d'extinction par la destruction des forêts, son habitat naturel. Elle est actuellement estimé à 1500 individus (Will Masefiel, 2003).

KOMOFLORA

Mise en place récemment, cette organisation se veut comme le défenseur de la flore des Comores.

I.3.2- Cadre juridique de l'environnement

Au niveau nationale, en matière de législation, les Comores sont dotées depuis 1992 d'une *Loi cadre relative à l'environnement* qui s'articule à la PNE et PAE.

Des textes d'applications relative à cette loi cadre un *Décret portant protection des espèces de faune et flore sauvages des Comores*, renforcer les dispositifs réglementaires de cette loi cadre. Toutefois ces dispositions restent inapplicables par l'absence des moyens humains et matériels.

Au niveau international, les Comores ont adhéré à la Convention de la Biodiversité et ratifié plusieurs convention relative à la protection de l'environnement.

I.3.3- Les Aires protégées : Le Parc Marin de Mohéli (PMM)

Le PMM est la première et unique aire protégée des Comores. Mise en place par le FEM (GEF en anglais), il c'est un outil pour la gestion de ressources marines par une gestion communautaire des localités riveraines du site.

II- ECOSYSTEMES FORESTIERS DU KARTALA

La Grande Comores, l'île la plus jeune, la plus grande et la plus peuplée abrite le Kartala, un volcan toujours en activité. Le massif du Kartala représente toutes les formations forestières qu'on peut retrouver dans les autres îles ainsi que d'autres formations qui lui sont spécifiques. Etudier les forêts du Kartala, c'est aussi étudier les différentes formations des autres îles.

I.1- Description du Kartala

Le Kartala est un grand volcan quaternaire en forme de dôme à pente forte (de 20 à 30 degrés sur les "grandes pentes") avec une vaste caldeira sommitale plus de 3km de diamètre, la plus grande du monde. Sa topographie est hérissée de nombreux cônes stromboliens de scories et de coulés de laves, surtout vers le nord et vers le sud. Il culmine à 2360 m au sommet duquel la température peut atteindre le 0°C.

Le massif du Kartala est subdivisé en deux grandes forêts. La forêt du Kartala proprement dite dense et humide sur les grandes pentes occidentales se différencie nettement des fourrés orientaux qui sont sèches et pauvrement peuplés.

II.2- Différenciation de la forêt du Kartala.

La forêt du Kartala qui fait l'objet de notre présentation est localisée sur le versant ouest, exposée aux vents humides, entre 600m et 1200 m d'altitude sur une superficie de 6300ha. Elle est constituée de plus de 144 essences recensées selon l'altitude (Battistini et Verin, 1984), des fougères arborescentes épiphytes ou terrestres et une diversité d'orchidées, des plantations de bananiers, des cultures maraîchères et de tubercule.

Trois grands niveaux de strates végétatives constituent la forêt du Kartala : La forêt dense de moyenne altitude relativement secondarisé, la forêt dense de haute altitude et une formation éricoïdale au sommet. De 1969 à 1984, cette forêt a passée de 19850 ha 8676 ha (Agra et Hydritecnik)

II.2.1- Forêt dense de moyenne altitude

Elle est localisée entre 600 et 1200 m d'altitude. La pluviométrie est de 2 000 mm par an, la température du mois le plus froid est supérieure à 15°C et le nombre de mois secs n'excède pas deux. En fonction de leur exposition et de la profondeur du sol, elle présente une futaie d'arbre de 15 m constituée par une diversité d'espèces indigènes comme l'*Anthocleista grandiflora*, des *Ficus*, le *Tambourissa leptophyllas*, le *Weinmannia comorensis*, l'*Ocotea comorensis*, le *Nuxia pseudentata*, des fougères arborescentes isolées, une diversité de fougères terrestres, plusieurs orchidées épiphytes.

C'est une formation très fragilisée par la forte pression anthropique qui s'exprime par un besoin incessant de terre cultivable et la diversification sur l'usage du bois (ébénisterie, construction des habitats locaux, ménage). En haute altitude de cette forêt, on pratique l'agroforesterie par la culture en sous bois des bananiers et des taros. A ce niveau persistent des grands arbres parfois dépourvus de jeunes plantes. En basse altitude, on développe une culture de subsistance qui exige un ensoleillement comme le manioc, la patate douce, la canne à sucre à usage traditionnel ou des cultures maraîchères. L'abandon de certaines friches favorise l'établissement de certaines plantes exotiques en l'occurrence le *Clidemia hirta* et le *Lantana camara*, le *Psidium cattelianum*, le *Syzygium jambos*. Les forêts denses de moyenne altitudes sont aussi présentes dans le Nord de l'île (Forêt de la Grille) et dans les autres îles de Mwali et de Ndzuani.

II.2.2- La forêt dense de haute altitude

Elle se situe entre une altitude de 1 200 et 1 800 m sur un sol basaltique humide riche mais peu épais. L'humidité est permanente avec des précipitations dépassant 6000 mm par an et sans saison marquée. La strate arborescente dépassant les 30 mètres est dominée par une flore indigène du genre *Nuxia*, *Olea*, *Macaranga*, *Dombeya*, *Tambourissa*, *Gastonia*, *Polycias*, *Schefflera*, *Ficus*, *Anthocleista*, *Weinmannia*, *Eugenia*, *Carissa*, Une diversité de fougères dont une abondance d'énormes fougères arborescentes, de nombreuses orchidées épiphytes dont on estime à plus d'une cinquantaine endémiques. Elle représente une superficie d'environ 5000 hectares et mérite d'être intégralement protégée. L'agroforesterie est pratiquement absente. Cependant, des coupes fréquentes d'arbre sciaphile peut être observées dans les sites proches des villages plus peuplés : les villages de Kourani au Sud ou Mvouni au Nord. Cette pratique fait ouvrir des trouées et favorise l'installation de quelques pieds de goyavier de Chine ou de buisson de *Clidemia hirta*. En zone transition, à l'entrée de la formation éricoïdale, existent des prairies où est pratiquée l'élevage des zébus en vagabondage. Quelques pieds de *Solanum mauritanium* peuvent être observés dans ces zones ainsi des buissons d'hortensias, des rosiers et les autres. Ces dernières plantes ont été introduites par les colons du XIX^e siècle dans les actuelles ruines du site de la Convalescence pour des fins de floriculture afin de favoriser la repousse des graminées de pâturage dans les prairies, des incendies sont volontairement pratiqués dans cette zone transitions.

La forêt dense de haute altitude est une formation typique de forêts tropicale et spécifique du Kartala.

II.2 3- La forêt éricoïdale

On retrouve uniquement cette formation au Kartala entre 1800 et 2300 m d'altitude sur des pentes les plus accidentées. Elle est constituée principalement des *Philippia* dont *P. montana* et le *P. comorensis*. La hauteur des arbres est entre 6 et 9 mètres. Elle représente la zone de transition entre la forêt dense de haute altitude et la caldeira sommitale. Au pied de ces plantes se développent des espèces de fougères et orchidées. Cette formation est constituée par des essences très inflammables soumise à des fréquentes incendies parfois d'origine criminels.

II.3- Richesse faunistique

Les connaissances sur la faune sont très incomplètes. Dans l'ensemble des îles l'avifaune se compose de 101 espèces, l'entomofaune de 1106 espèces, l'erpétofaune de 21 espèces dont 10 endémiques (Moulaert, 1998). Notons que la faune mammalienne est pauvre, marquée néanmoins par la présence dans les autres îles de deux espèces de lémurien et la grande roussette de livingstoni (*Pteropus livingstonii*) tous menacés d'extinction.

Le forêt du Kartala héberge cinq espèces d'oiseaux endémiques gravement menacés : *Zosterops moroniensis*, *Otus poliani*, *Umblotia flavirostris*, *Dicrus fuscipennis*, *Dicrus walenii*. D'autres espèces encore très fragilisés sont le Pigeon bleu des Comores, le Perroquet Noir ou *Corcopsi vasa*, le Gros pigeon brun ou *Columba polleni*.

On retrouve en basse altitude des lézard dont certains sont endémiques.

III- LES MENACES

III.1- Calamité naturelle

Les Comores sont à l'abri de grandes dépressions tropicales et les cyclones se font rares. Cette condition favorise le développement d'une forêt avec une haute futaie d'arbre qui peut atteindre les 50 m. Toutefois, le volcan Kartala, toujours en intense activité représente une grande menace permanente de la diversité biologique qui se développe dans cette forêt. Dans les temps, plusieurs forêts naturelles ont été dévasté par les laves et des signes de roches basaltiques nues persistent actuellement dans les parties sud et nord de la forêt.

III.2- Pression anthropique

Dans un pays où 80% de la population active sont des agriculteurs la pression anthropique sur les forêt s'observe par :

- Le besoin incessant de terre cultivable en particuliers dans les grosses habitations proche des forêts domaniaux.
- La diversification sur l'utilisation du bois de construction des habitats locaux, bois d'ébénisterie et bois de ménage. La plus grande majorité de la population comorienne utilise le bois comme source d'énergie dans les ménages et les distilleries de fleur à parfum. En 1982 Morel a estimé l'exploitation du bois usage domestique à 1m³ ou 500 Kg par personne et par an.
- La commercialisation locale des pots de fougères arborescentes.
- Le vagabondage de zébu en pleine forêt.

- Le feu de brousse faire repousser les herbes de pâture.
- La naissance d'un écotourisme non organisé et non réglementé. Il est à constater des montées fréquentes de touristes locaux et étrangers au sommet du Kartala. Aucune réglementation n'est en vigueur sur la gestion de déchets touristiques, le respect de la nature et d'autres aspects de contrôle et de l'environnement par des visiteurs.
- L'usage d'engrais chimique et de pesticides dans les cultures maraîchères pratiquées dans les prairies des hautes altitudes.

III.3- Les plantes exotiques envahissantes

III.3.1- Origine des introductions

Les données sur les introductions de plantes exotiques dans l'archipel sont disparates. Ces introductions sont bien entendu intimement liées à la présence humaine (Vos 2003). Dans les îles du Sud/Ouest de l'Océan Indien, les Comores sont les plus anciennement peuplées (VIII^e siècle). Ce qui laisserait croire que l'introduction des plantes exotiques aux Comores serait plus ancien que les autres îles. Or l'impact de l'occupation humaine n'est néanmoins connu qu'à partir de la mise en valeur des terres par les Français au XIX^e siècle. De 1846 à 1886, des planteurs venus en majorité de La Réunion développent la monoculture de la canne à sucre, et accessoirement celles du café et du cacao. En 1870, Gevrey pense que les forêts n'occupent plus qu'un sixième des surfaces des îles (Gevrey, 1870). Il cite 60 espèces de plantes ornementales et cultivées introduites parmi lesquels il est intéressant de mentionner l'agave (*Agave sisalana*), *Albizia lebbek*, *Casuarina equisetifolia*, *Syzygium jambos*, *Acacia* sp., *Psidium* sp., *Syzygium aromaticum*, *Cinnamomum verum*, aujourd'hui toutes envahissantes. Vers 1910, avec l'abandon de la canne à sucre pour des raisons socio-économiques, des sociétés coloniales ont introduit la vanille, la girofle, le sisal, et surtout les plantes à parfum dont le fameux ylang ylang (*Cananga odorata*).

III.3.2- Le problème des plantes exotiques envahissantes

A ce jour aucun projet de gestion de plantes exotiques envahissantes n'est en étude. Dans le cadre d'un programme de la FAO des îles du Sud Ouest de l'Océan Indien, un expert de la région s'est rendu aux Comores au mois de mars 2003 en vue de faire une étude sur les plantes ligneuses exotiques envahissantes. Il s'agirait de la première étude effectuée aux Comores en matière d'inventaire et de statut des plantes exotiques envahissantes.

Or aux Comores le problème des invasions de plantes exotiques existe malgré qu'il n'est pas encore perçu comme un danger réel de l'environnement par les décideurs. Aucune liste officielle des plantes exotiques n'est encore établie. En matière de prévention, la législation en vigueur interdit l'introduction aux Comores d'espèces vivantes animale ou végétale sans une autorisation préalable des autorités compétentes. Force est de constater que cette réglementation n'est pas encore applicable. Quant aux projets environnementaux en cours d'exécution ou en instruction la dimension « plantes exotiques envahissantes » n'est pas prise en considération.

III.3.- Les principales plantes envahissantes

Si on considère les données de Vos, l'archipel des Comores compte 16 espèces envahissantes dont certaines ont des statuts différents selon l'île. Certaines de ces espèces ont été introduites dès le XIX^{ème} siècle, notamment les fruitiers, les épices et certaines espèces multiusages à croissance tandis que d'autres espèces (de reboisement, lutte contre l'érosion...) ont été introduites plus tard au cours du XX^{ème} siècle.

Dans la forêt du Kartala nous pouvons dénombrer deux catégories de plantes exotiques : Les plantes exotiques envahissantes et les plantes exotiques potentiellement envahissantes.

III.3.3.1- Les plantes exotiques envahissantes

Pisidium cattleianum ou Goyave de chine

Il est connu localement sous l'appellation Mstongama. Ses fruits très savoureux sont appréciés pour être commercialisés dans les centres urbains. La qualité de son bois, dur et résistant est utilisée pour la construction de habitats locaux et la fabrication du charbon. On le retrouve en abondance dans toutes les formations forestières de l'île de Ngazidja au Kartala, dans les formations secondaires, il représente un foyer néfaste pour l'envahissement progressif de la forêt naturelle à la moindre ouverture de son couvert pour la mise en culture de nouvelles parcelles. Dur à arracher par ses racines qui s'enfoncent très profondément, il pose de véritables problèmes aux défricheurs. Ces derniers abandonnent les foyers censés par le *pisidium* au profit de nouvelles terres de plantes indigènes pour défricher.

Aucun programme de lutte n'est encore. Toutefois l'usage de son bois pour faire du charbon pourrait constituer un des moyens pour mener une campagne d'éradication à condition qu'on restaure très rapidement les espaces déjà avec d'autres espèces indigènes. *P. cattleianum* est très présent à Ngazidja mais peu connu à Mwali et Ndzواني. Il a été constaté une introduction volontaire de quelques pieds pour des fins agricoles. Une campagne d'éradication poserait nécessairement un conflit d'intérêt.

Clidemia hirta

Connu sous le nom de *Désiré* à Mwali, l'introduction semble être très récente. Son nom local tire son origine par le prénom d'un expatrié malgache qui a donné ses vertus médicinales aux habitants de l'île. Son origine dans notre sous-région proviendrait probablement de Madagascar. En effet Canabis note en 1970 qu'il provient d'un mélange d'un lot de grain en provenance de Java pour être essayé dans une station agricole du Sud de l'île. Elle s'est échappée très rapidement depuis 1914 dans les bas fonds et les territoires déforestés de la côte Est. Elle est bien présente à Ngazidja dans les forêts secondaires où la moindre trouée peut lui être profitable pour s'y installer. Elle se développe très rapidement dans les champs abandonnés, et par sa rusticité et sa plasticité, elle devient très difficile à défricher dans les champs en jachère. Cette plante est reconnue comme une mauvaise herbe nuisible aux cultures. Elle ne poserait pas aucun conflit d'intérêt lors d'une campagne d'éradication qui aurait l'adhésion des agriculteurs.

Syzygium jambos

Originnaire d'Inde et de la Malaisie, cette espèce se développe dans la forêt de basse et moyen altitude en cohabitation avec la Goyave. Elle représente une menace claire pour les vestiges de forêt humide. Au Kartala en versant ouest, entre les zones de cultures envahies et la forêt naturelle elle développe un taillis dense mono spécifique de *P. cattleianum*.

Lantana camara

Le *Lantana* est présent partout dès qu'une trouée existe ; il est beaucoup plus abondant en zone sèche où sa progression ne semble plus pouvoir être stoppée. Il n'a pas encore été constaté dans les hautes altitudes du Kartala, par contre il est très présent en basse altitude. C'est une plante cosmopolite, elle serait introduite aux Comores par une société coloniale qui l'exploitait comme plante à parfum par la fabrication du concret.

III.3.3.2- Les plantes exotiques potentiellement envahissantes

D'autres plantes ont été introduites aux Comores pour de fin de reboisement, de restauration du sol, ou comme tuteur de vanille.

Gliricidia speciosa

Le *Gliricidia* est présent dans les 3 îles. Il a une croissance et une propagation très rapide. A Ngazidja on l'utilise comme tuteur de vanille. A Ndzuanani, il a connu une large diffusion grâce à une vaste campagne de restauration du sol menée dans cette île au début des années 90. Il s'adapte en milieu humide comme en milieu sec. Il pousse sans difficulté sur les laves récentes du Kartala. Il appartient à la grande famille des légumineuses qui ont les propriétés de fixer l'azote de l'air. On l'utilise comme clôture des champs et plante de fourrage. Ses usages multiples et la commercialisation des boutures laissent prévoir une éventuelle invasion dans l'île. D'où un strict contrôle afin d'éviter une introduction spontanée ou volontaire dans les reliques forestiers.

Eucalyptus

Les eucalyptus a été largement introduits dans les milieux des années 80 lors d'un vaste programme nationale de reboisement. Elles sont très localisées à Ngazidja sur des vastes parcelles dans la Forêt de la Grille au Nord de l'île et dans les hauteurs du nord du capital. Ils sont aussi plantés en moyenne altitude de Kartala autour de l'ancienne scierie coloniale de Nioumbadjou ou replanté sur les routes pour des fins de paysage.

Les eucalyptus ne constituent pas encore de foyer très dangereux pour la flore indigène étant donné qu'ils sont plantés dans les badlands. Toutefois, ils méritent d'être strictement contrôler afin d'arrêter une éventuelle, propagations dans les forêts indigènes.

Cinnamum zeylanicum

Le *Cinnamum* communément connus sous le nom de *Cannelle* serait probablement introduit aux Comores par les colons pour des fins commerciales. Il est entretenu dans les champs pour ses vertus aromatiques, médicinales.

Actuellement aucun signe d'invasion de cette plante n'est observé bien qu'elle mérite d'être surveillée. En effet cette espèce se présente comme une redoutables peste végétale dans les forêts seychelloises.

Mimosa pudica

Le *Mimosa* ou *Sensitive* est présent en basse altitude du Kartala. Il se développe sous forme de vastes buissons lianescent dans les friches, dans les cultures abandonnées où il est observé jusqu'à 800 m d'altitude. Munie des épines sous forme de crochets, il pose de sérieux problèmes aux défricheurs. Il ne constitue pas un danger réel pour la flore indigène.

IV- PERSPECTIVE DE MISE EN VALEUR DES ECOSYSTEMES FORESTIERS DU KARTALA

Les forêts du Kartala comme celles des autres forêts des Comores représentent des énormes potentialités pour le développement socio-économiques du pays. Leurs mises en valeur ainsi que leurs ressources qui les constituent doivent être perçus d'une manière globale à travers les programmes de développement socio-économique (environnement, développement rural, agriculture, tourisme, recherche scientifique, éducation nationale....) que le pays mettrait en œuvre.

IV.1- Développement agricole

Le développement agricole d'un pays est intimement lié à la gestion de ses réserves forestières. Ceci passe donc par une gestion rationnelle de l'espace forestier en délimitant des zones d'agriculture vivrières, des produits de rente, d'élevage, de culture maraîchère et d'exploitation du bois pour ses divers usages, de stricte conservation de la biodiversité.

IV.2- Rénover un secteur de « Tourisme vert »

Les îles Comores sont célèbres pour avoir abriter des sites d'intérêts touristiques. Le Kartala est l'un de meilleurs sites des Comores par sa diversité de paysage et la biodiversité qu'il renferme. La mise en valeur du Kartala pour des fins touristiques nécessitent d'œuvrer pour :

- Faciliter l'accès par des marquages des sentiers : Sentier botanique, points de relaxe.
- Former des guides professionnelles écotouristiques capables de faire connaître aux visiteurs la diversité biologique, des historiettes et anecdotes associées aux sites et surtout capable de respecter et faire respecter l'environnement.
- Réglementer l'accès en forêt ainsi que la gestion des déchets apportés par les visiteurs. Il a été constaté l'abandon de plusieurs déchets en pleine forêt naturelle et la coupe fréquente des arbres par les campeurs.
- Faire une promotion du site auprès des opérateurs touristiques, nationaux, régionaux et internationaux.
- Créer des centres relais écotouristiques (cabanes) où les visiteurs et/ou les scientifiques peuvent bien y séjourner.

IV.3- Recherche scientifique

La recherche scientifique porterait sur

- Un inventaire plus exhaustif de la biodiversité (faune et flore).
- La diffusion de l'information par des publications accès au public scientifique et au grand public : Guide, affiche, dépliants, plaquettes qui décrivent le paysage et La diversité biologique du site.
- La mise en valeur de ressources naturelles, recherche et gestion des plantes médicinales, gestion rationnel des espèces à valeurs ajouter (respect des quotas d'exportation, des reptiles, d'oiseux).

IV.4 – Création d'un parc naturel

Une gestion durable d'un écosystème forestier passe nécessairement par la mise en place d'une aire protégée dans une partie de l'écosystème. En ce qui concerne le Kartala il peut-être gérer de la suivante :

- Protection intégrale de la forêt dense de haute altitude, de la formation éricoidale et du caldeira : Accès strictement contrôlé, stricte interdiction d'exploitation des ressources que pour des fonds d'étude scientifique préalablement autorisée par l'autorité compétente.
- Gestion rationnelle des formations secondaires de moyennes altitudes
 - Coupe autorisée des bois.
 - Gestion de terres agricoles.
 - Participation des communautés riveraines sur la gestion du site.
- Recherche des solutions d'alternatives par d'autres initiatives économiques :
 - Écotourisme.
 - Amélioration quantitative de la production agricole.
 - Diversification des activités agricoles.

IV.5- Programme de restauration des écosystèmes

Ce programme consisterait à

- Replanter des espaces ouverts par plantes indigènes
- Mener une campagne de prévention, de sensibilisation et d'éradication des plantes exotiques envahissantes
- atténuer les conflits d'intérêt concernant la gestion certains « pestes végétales ». Le cas de goyave rouge.

IV.5- Renforcement des capacités institutionnelles

Cette renforcement de capacités consisterait à :

- Responsabiliser un organe compétant (ONG et/ou institution publique) charger de gérer le site et ses ressources.
- Former des écouguides et écougardes capables d'assurer des fonctions de gardien, de gestionnaire de l'environnement.
- Réglementer (loi) sur la gestion des écosystèmes du Kartala.
- Dynamiser la coopération régionale, et internationale en matière de gestions de la biodiversité.

- Appuyer la recherche scientifique portant sur les connaissances et la mise en valeur de la diversité biologique.

Conclusion

L'environnement aux Comores à l'instar des pays voisins s'inscrit comme priorité nationale pour assurer un développement humain durable de toutes les générations de nos populations. Contrairement aux autres pays, les Comores accusent un grand retard en matière de gestion de ses ressources naturelles dont la nature leurs a conféré plusieurs traits originaux mais très fragilisés (taux d'endémisme, diversité de paysages, ..)

La prise de conscience de certains phénomènes dévastateurs de notre diversité biologique (invasions biologiques des espèces exotiques) devient un préalable, une nécessité avant la mise en œuvre de tout programme de développement. Un travail de formation et d'information au bénéfice des acteurs de terrains est la priorité de priorité afin de les impliquer d'avantage sur la gestion de leur avenir et leur bien être : une gestion rationnelle de l'environnement. D'autres atouts sont à mettre à profit, la coopération régionale afin de bénéficier la riche et longue expérience des pays voisins surtout ceux qui eu à partager avec les Comores une histoire et un paysage commun.

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Communication des Comores à L'atelier Regional portant sur la Lutte contre les Espèces Exotiques Envahissantes et la Réhabilitation des Ilots et des Sites Terrestres de Grand Intérêt Ecologique

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Résumé

L'introduction et la colonisation des plantes exotiques dans les milieux indigènes constituent une des menaces des écosystèmes terrestres en Union des Comores. Les trois zones retenues prioritaires pour la création du réseau national d'aires protégées terrestres connaissent ce phénomène d'invasion biologique.

Aux Comores, il n'y a jamais eu de liste officielle de plantes envahissantes et la première étude a été réalisée en mars 2003. Au cours de cette étude 16 espèces de plantes ligneuses ont été identifiées comme sérieusement envahissantes. A cette liste il faut rajouter les espèces de lianes qui étouffent le végétation forestière et les végétaux inférieurs envahissants. Parmi ces 16 espèces, 8 sont très problématiques et nécessitent une priorité de gestion.

Ces plantes essentiellement introduites pour des reboisements, bois d'oeuvre, espèces fruitières, épices, ornementales, bois de chauffe, fourrage ou tuteurs de vanille, menacent à la fois les cultures et la végétation forestière du pays et méritent une attention particulière dans le cadre de la conservation à long terme des écosystèmes indigènes.

La présente présentation sera basée sur l'évolution des ces plantes en milieu agricole et forestier et les techniques traditionnelles de lutte contre cet envahissement.

Abstract

The introduction and colonisation of alien plants into indigenous ecosystems represents one of the main threats to the terrestrial ecosystems of the Comoros Islands. The three designated priority areas for the creation of a national terrestrial protected area network are affected by invasive species.

No official list of invasive plant species has ever been produced for the Comoros and the first study on the introduced flora was only carried out in March 2003. 16 woody plant species were identified as serious invaders. Climbers that smother the forest vegetation and the lower canopy invasives must also be added to this list. Among these 16 species, 8 are very problematic and need to be managed as a matter of priority.

These plants were generally introduced for reforestation, for timber, as fruit trees, for spices, as ornamentals, for fire wood, forage or supports for vanilla, are endangering both cultivation and the forests of the country that deserve particular attention for the long term conservation of indigenous ecosystems.

This presentation will be based on the dynamics of these plants in agricultural and forest systems and the traditional techniques used in the fight against this invasion.

Introduction

Ce présent rapport s'inscrit dans le cadre de l'atelier régional portant sur la lutte contre les espèces exotiques envahissantes et la réhabilitation des îlots et des sites terrestres de grand intérêt écologique.

Bien que seulement une des quatre îles de l'archipel des Comores (Grande Comore) soit l'objet de cette évaluation, nous ferons aussi parfois référence à l'ensemble de deux autres îles (Anjouan et Mohéli) de l'Union des Comores.

C'est ainsi que le plan du rapport est structuré de la façon suivante :

- Brève présentation de la biodiversité terrestre de l'Union des Comores
- Stratégie Nationale en matière de conservation de la biodiversité terrestre
- Principales menaces et causes sous-jacentes
- Priorités en matière de conservation de la biodiversité terrestre
- Recommandations en vue de promouvoir les options d'atténuation et/ou d'éradication de l'énigme sur les plantes envahissantes.

Biodiversité terrestre en Union des Comores

L'archipel des Comores dispose d'un patrimoine naturel riche et varié et qui se caractérise par une multitude d'habitats, notamment terrestres avec leurs espèces associées. Ce potentiel d'une grande importance du point de vue diversité biologique avec de nombreuses espèces vulnérables, en danger critique, menacées d'extinction et /ou endémiques, est mal connu, et de ce fait, mal géré et mal protégé.

Contexte socio-économique

L'union des Comores est l'un des plus pauvres pays au monde. Selon les statistiques de 1998 l'Etat compte une population d'environ 530 000 habitants (PNUD, 1999) pour un produit national brut par habitant de l'ordre de 370 \$ US (PNUD, 1999), alors que le PNB moyen par habitant s'établit à 480 \$ US pour les pays africains au sud du Sahara et à 520 \$ US pour l'ensemble des pays à faible revenu. De 1992 à 1998, le taux de croissance annuelle de la population est d'environ 2,6 % (PNUD, 1999). Le taux de croissance du PIB serait de l'ordre de 2,6% (BCC, 2002) après une hausse de 1,9% en 2001. Cette amélioration de l'activité économique est le résultat de facteurs tant internes et externes. Au cours de l'année, les Comores ont bénéficié sur le marché international d'une bonne orientation de cours de certains produits agricole de rente, amorcé depuis deux ans, et d'une conjoncture globalement favorable dans les secteurs du bâtiment et des travaux publics et de l'artisanat.

Dans l'ensemble des îles de l'union des Comores, la population est essentiellement rurale. Plus de 80 % de cette population dépend quotidiennement des ressources naturelles pour se loger (bois de construction), s'alimenter (agriculture et pêche) et exercer des activités génératrices de revenu (culture de rente, écotourisme, bois d'œuvre, etc).

Un témoignage des chercheurs

Les Comores hébergent certaines espèces de flore parmi les moins étudiées et les plus menacées de l'Océan indien. L'ensemble de la flore des Comores compterait environ 2000 espèces (Adjanooun et al. 1982 in Moulaert 1998) mais seulement la moitié est connue. On début du dernier siècle, on comptait 771 espèces de Spermaphytes (plantes à fleurs et à graines) et 180 Ptéridophytes (fougères) (Voeltzkow 1916 in Moulaert 1998). Une étude plus récente (Moulaert 1998) établit à 175 le nombre d'espèces et taxons infraspécifiques de Ptéridophytes, dont 9 endémiques, et à 72 celui des Orchidées, dont 36 espèces endémiques.

De plus, cet archipel figure en premier (devant Maurice et les Seychelles) sur la liste des 20 petites îles ou archipels caractérisés par un nombre restreint d'espèces (attribuable à l'exiguïté du territoire) mais dont le taux d'endémisme est exceptionnel (Caldecott 1994). Cet archipel volcanique connaît un degré de priorité élevé pour la conservation de la biodiversité à l'échelle mondiale: les Comores comptent une grande diversité de plantes et un endémisme important qui en font un lieu d'intervention hautement prioritaire pour la conservation de la biodiversité mondiale (WWF & UICN 1995). Les Comores sont classées parmi les 221 zones d'endémisme considérées comme essentielles à l'échelle mondiale dans le cadre de la conservation de la diversité et de l'endémisme de l'avifaune (ICBP 1992 in Bruno Paris 1999).

Une évaluation non exhaustive de l'endémicité aux Comores

L'unicité de cette richesse biologique est révélée par les taux d'endémisme élevés mesurés pour les groupes taxonomiques qui ont fait l'objet d'études. De nombreuses espèces sont encore inconnues de la science et les inventaires très incomplets ne permettent pas d'apprécier la richesse spécifique de plusieurs groupes taxonomiques. En effet, le taux d'endémisme global estimé pour la flore comorienne est de 33%, atteignant 50% pour le groupe des orchidées. Le taux d'endémisme moyen pour les fougères est de 15%. Bien que le groupe des insectes ait bénéficié de très peu d'études, les taux d'endémisme observés chez les familles des lépidoptères et des coléoptères sont respectivement de 34% et 24%. Le taux d'endémisme des reptiles terrestres serait de 44%. Pour les oiseaux le taux d'endémisme spécifique est estimé à 25% et le taux sous-spécifique à 75%. Quant aux mammifères, le taux d'endémisme est évalué à 14%.

Stratégie Nationale en matière de conservation de la biodiversité

La conservation et la valorisation du patrimoine national et, plus particulièrement la protection de la biodiversité constitue une des priorités des Comores en matière d'environnement.

Les actions réalisées dans ce domaine sont :

Stratégie nationale et Plan d'action pour la biodiversité

En tant que Partie à la Convention sur la diversité biologique, les Comores ont défini une stratégie et un plan d'Action pour la conservation de la biodiversité. Les objectifs poursuivis sont (i) la préservation de la diversité biologique (ii) la gestion rationnelle et

durable des ressources naturelles et des espèces (iii) le partage équitable des bénéfices de la biodiversité.

Les axes stratégiques

Pour atteindre ces objectifs visés ci haut, les axes stratégiques suivants ont été identifiés :

- La protection, la conservation et la restauration du patrimoine naturel des Comores.
- Le renforcement de la capacité institutionnelle en matière de conservation de la diversité biologique.
- L'élaboration des décrets d'application en matière de gestion et de protection de l'environnement.
- La valorisation du point de vue économique, social, scientifique et culturel de la diversité biologique en vue d'une gestion rationnelle des ressources naturelles.
- La réduction de la pression sur les ressources naturelles par la recherche de solutions alternatives.
- Le renforcement de la sensibilisation et de l'éducation environnementales en vue d'une approche collective et d'une démarche participative.

Les actions prévues au titre de la stratégie nationale de conservation de la diversité biologique concernent :

- Les espèces de faune et de flore et les aires prioritaires
- Les mesures sectorielles

Principales menaces pesant sur les écosystèmes et les espèces

Menaces et causes sous jacentes

Les écosystèmes indigènes en Union des Comores sont soumis à une déforestation anarchique en l'absence d'une gestion globale et intégrée des terres. Ce phénomène est lié à la croissance démographique (2,7%) et à la pauvreté de la population qui cherche à s'approprier des parcelles ou en quête de terres agricoles.

La déforestation excessive déclenche l'érosion des sols dont la cohésion n'est plus assurée par les systèmes de racines de la végétation. Cette érosion entraîne par la suite une forte sédimentation littorale, provoquant un étouffement des coraux et des herbiers marins. C'est actuellement le principal facteur de dégradation des récifs frangeants de Mohéli, notamment dans le Parc Marin. La régression de la forêt entraîne la disparition des habitats naturels pour de nombreuses espèces, la prolifération d'espèces exotiques envahissantes comme le jamrose (*Syzygium jambos*, *Psidium cattleianum*, etc). Enfin certaines espèces de bois précieux, d'orchidées et autres espèces menacées sont surexploitées.

Problemes	Causes sous – jacentes
<i>a.) Forêt naturelle</i>	
Disparition de la Forêt naturelle au profit de l'agriculture	Absence de politique foncière et forestière pression démographique pas d'emploi et d'Activité Génératrice de Revenu (AGR) . L'agriculture reste la seule alternative
Déboisement pour la production du bois d'œuvre et de service	Pas d'application des législations et des réglementations en vigueur nombre d'espèces préférées réduites besoins importants par rapport à la potentialité
Coupes sauvages pour la production du charbon de bois	Pas d'application des législations et des réglementations en vigueur
<i>b.) Cultures sous bois</i>	
Dégradation du milieu par	Normes des DRS non respectés
l'épuisement du sol et l'érosion	Pas de politique de gestion.
Mutation d'une agriculture sous bois en un système de cultures manioc maïs-embreva ...	Abattage et écorçage des gros arbres l'érosion accélérée

Tableau 1.a. Des principales menaces et causes sous – jacentes: 1. Ecosystème Terrestre

Problèmes	Causes sous – jacentes
<i>a.) Les fougères arborescentes</i>	
Utilisation des troncs de fougère comme pot à fleur destiné à la commercialisation	Pas d'application des législations et de réglementations en vigueur pas d'emploi ou AGR méconnaissance des espèces de fougères manque de sensibilisation demande commerciale
Destruction de son aire écologique par le déboisement	Manque de gestion de l'espace (défrichage agricole) Pas d'application des législations et de réglementations en vigueur
<i>b.) Les Orchidées</i>	
Destruction de son aire écologique par le déboisement	manque de gestion de l'espace (défrichage agricole) Pas d'application des législations et de réglementations en vigueur
Prélèvement pour la commercialization	Pas d'application des législations et de réglementations en vigueur pas d'emploi ou AGR demande commerciale
<i>c.) Bois précieux</i>	
Utilisation dans l'ébénisterie et les ouvertures	Espèces d'exploitation réduites forte demande coût abordable que le bois importé technologie moins avancée

Tableau 1.b. Des principales menaces et causes sous – jacentes: 2. Espèces végétales

Problèmes	Causes sous – jacentes
a.) <i>Les roussettes</i>	
Détérioration de l’habitat par la déforestation	Manque de gestion de l’espace absence de politique forestière Pas d’application des législations et de réglementations en vigueur
Assèchement des rivières dû au déboisement	Manque de gestion de l’espace
Réduction du site d’alimentation	Déboisement
b.) <i>Les oiseaux</i>	
Destruction de l’habitat par la déforestation	Absence de gestion de l’espace Pas d’application des législations et de réglementations en vigueur

Tableau 1.c. Des principales menaces et causes sous – jacentes: 2. Espèces animales

Cas de l’envahissement végétal

Les zones terrestres potentiellement retenues prioritaires pour la création du réseau national d’aires protégées n’échappent malheureusement pas à ce phénomène d’invasion biologique (la Forêt du Karthala en Grande Comores, la forêt du mont Ntringui sur l’île d’Anjouan et la forêt de Mlédjelé à Mohéli). Et pourtant les espèces indigènes et/ ou endémiques menacées par cette colonisation présentent un intérêt national qu’international majeurs pour les générations présentes et futures. En effet, certaines de ces espèces sont et pourraient être à l’origine des médicaments et de la nourriture d’aujourd’hui et demain.

Les espèces envahissantes n’ont pas encore fait l’objet d’une préoccupation majeure aux Comores en raison de l’inconscience sur le danger afférent. Excepté les techniciens, cette notion d’envahissement reste obscure et non interprétée en tant que tel. La présence et les dangers de ces espèces y sont réels .

Statut de l’invasion végétale en Union des Comores

Les principales espèces ligneuses et non ligneuses ont été introduites en Union des Comores à des fins différents : bois d’œuvre, espèces fruitières, essence de reboisement pour limiter l’érosion, épices, plantes médicinales, bois de chauffe, ornemental, fourrage, tuteur de vanille, etc. Ainsi, 16 principales espèces ligneuses sont considérées comme envahissantes parmi lesquelles 8 méritent une attention de gestion particulière.

<i>Acacia mangium</i> (*)	<i>Jatropha curcas</i>	<i>Senna</i> sp.
<i>Acacia auriculiformis</i> (*)	<i>Lantana camara</i> (*)	<i>Spathodea campanulata</i> (*)
<i>Albizia lebbek</i>	<i>Leucaena leucocephala</i>	<i>Syzygium aromaticum</i>
<i>Cinnamomum verum</i>	<i>Litsea glutinosa</i> (*)	<i>Syzygium jambos</i> (*)
<i>Clidemia hirta</i> (*)	<i>Psidium guajava</i>	
<i>Gliricidia sepium</i>	<i>Psidium cattleianum</i> (*)	

Tableau 2. Liste des espèces des plantes ligneuses envahissantes. * priorité de gestion

Evolution dans les habitats riches en biodiversité terrestres

Forêt humide de moyenne altitude

Forêt humide d'altitude dite de « nuage »

Impacts économiques et environnementaux

Impacts positifs (valeur social des plantes envahissantes/fonction des objectifs d'introduction).

Impacts négatifs (agriculture et écosystèmes/ biodiversité) : modification des nutriments et du couvert végétal, appauvrissement et disparition des espèces de faune et flore indigènes, etc.

Contrôle et restauration des habitats

Contrôle : biologique, chimique et mécanique

Le contrôle biologique et chimique restent encore non appliqué. Quant au contrôle mécanique, il est le mieux appliqué même si c'est de façon très traditionnelle. Les espèces non utilisées en fourrage sont conservées comme paillage en parcelle. « Sur les 22 espèces rencontrées sur les parcelles, 7 ne trouvent pas d'utilisation en paillage du fait de leur capacité reconnu par les agriculteurs à se multiplier facilement végétativement (draft rapport FAO, mars 2003) ». c'est le cas de *L. camara*, *Senna* sp,

Techniques traditionnelles de lutte contre l'envahissement végétal

En grande Comore, l'élimination de l'espèce ; *Psidium cattleinum* peut être liée à des objectifs différents que l'interprétation en soit d'une espèce envahissante. Certaines personnes coupent en abondance cette espèce pour en faire du charbon de bois ou de bois de construction. D'autres l'abattent pour installer des cultures vivrières tels que des bananiers, des taros, Ces agriculteurs peuvent aller jusqu'à déraciner les pieds de cette espèce en utilisant du feu ou des pioches., des plantoirs, ... La cueillette de ses fruits appréciés pour le jus consommés dans les ménages n'affecte pas en soit cette espèce.

Restauration

Les actions de restauration restent très limités et moins visibles sur le terrain. Quoiqu'il existe des « Padzas » à Mohéli, Grande Comore et Anjuan, la majorité de ces espaces restent nus. Les rares « padza » qui ont connu de restauration, cette initiative émane principalement des mouvements associatifs villageois.

Activités en matière de communication, éducation et sensibilisation du public sur les plantes envahissantes

- Thème abordé à partir d'autres thèmes et passe inaperçu

Mesures de conservation en vigueur ou proposées mais non encore appliquées

- Internationales (Conventions)
- Nationales (Politique Nationale de l'Environnement, Stratégie Nationale et Plan d'Action Environnemental, Loi Cadre Relatif à l'Environnement (art44 : interdiction d'introduction d'espèces exogènes sauf dérogation en fonction de l'intérêt de l'espèce), initiation du réseau d'aire protégées)
- Recherches (études très limités) scientifiques et équipements (n'existent pas)

Priorités en matière de conservation de la biodiversité terrestre

Cadre politique national

Devant l'urgence d'intervenir pour conserver la biodiversité, le Gouvernement de l'Union des Comores a fait montre d'un engagement sur le développement des outils législatifs en relation avec la conservation de l'environnement et de la biodiversité en particulier.

Il a élaboré et adoptée une politique national de l'environnement en 1993 par un décret présidentiel N° 93-214/PR, sur la base du document « Diagnostic de l'état de l'environnement aux Comores ». Cette politique national de l'environnement a pour objectif principal : « assurer une gestion durable et rationnelles des ressources naturelles et définir ou renforcer les politiques sectorielles »

Le gouvernement s'est engagé également pour ratifier des conventions de portée internationale telle que la convention sur la diversité biologique (1994), la convention CITES, la convention Ramsar et autres.

Au cours de la dernière décennie, il a adopté un Plan d'Action Environnemental (PAE, 1994), une Loi-cadre relative à l'environnement (Loi n° 94-018/AF adoptée en 1994 et consolidée en 1995 et en 2000), cadre juridique pour la mise en application du PAE.

On y reconnaît le caractère essentiel de la participation des communautés au développement du pays et la nature fondamentale du lien entre le développement durable et la saine gestion des ressources naturelles. La Loi-cadre relative à l'environnement a fait un grand pas en ce sens en reconnaissant un nouveau principe d'administration : « Les associations légalement formées et oeuvrant statutairement dans les domaines de la sauvegarde de l'environnement depuis plus d'une année, peuvent être agréées par le Ministre chargé de l'environnement pour participer à l'action des organismes publics ». L'Agenda 21, pour pallier aux contraintes et aux limites qui pèsent sur les administrations, recommande vivement des solutions institutionnelles nouvelles, notamment la dévolution d'une partie du mandat du service public à d'autres acteurs non-étatiques. Lors de la création de la première aire protégée des Comores, le Parc Marin de Mohéli, l'implication volontaire des communautés de base dans la gestion du parc a été formalisée par la signature d'accords de cogestion entre les associations agréées de chacun des villages du parc et les autorités locales chargées de l'environnement

Principaux acteurs

- L'Etat (institution : CNDRS, INRAPE, Projet Biodiversité, DGE... ;)
- CNDRS : gestionnaire de l'herbier national, supervision des mission d'étude sur l'avifaune aux Comores, la flore, ...
- Projet Biodiversité : initiateur du réseau national des aires protégées aux Comores, plan d'action de conservation des espèces (cas de la Roussette de Livingstone), développement de l'approche participative pour la gestion des ressources naturelles aux Comores, édition de bulletin d'éducation environnemental et des modules de formation en écologie, articles dans les journaux et des émissions à la radio & télévision

- Les Communautés locales (villages riverains des zones forestières)
- Reboisement
- Les ONG environnementales (Comoflora, Action Comores, AIDE, Ulanga, ..) ; reboisement, sensibilisation,

Recommandations :

Plusieurs actions sont menées sur le terrain de façon global pour la conservation de la biodiversité dans le cadre du projet Biodiversité qui a orienté ses efforts beaucoup plus sur la zone côtière et marine. Toutefois, les réalisations en matière de lutte contre l'envahissement végétale sont pratiquement négligeables. Les recommandations suivantes pourraient améliorer la situation. L'obstacle majeur est l'absence des ressources humaines et financières.

- Le renforcement des capacités nationales sur ce thème :
- Les techniciens (environnement, agriculture, police frontière, ...) doivent avoir la même vision du danger sur les plantes envahissantes. Par la suite, ils pourront assurer le relais pour la vulgarisation de l'information par tous les canaux appropriés devant toutes les structures concernées.
- Le développement d'un cadre légal adapté : Il faudrait que les différents textes établis à cet effet aient d'effet sur le terrain. De plus, il serait judicieux d'établir et d'approuver les textes d'application des décrets.
- La promotion de l'éducation et sensibilisation de toutes les structures concernées par ce thème (les agriculteurs, les décideurs).
- Les institutions concernées telles que le CNDRS, la DGE, l'INRAPE, les ONG, doivent être sensibilisées pour une meilleure appréhension du problème de l'envahissement en vue de les permettre de faire la bonne interprétation du problème (bonne vision des impacts négatifs au détriments des petits avantages sociaux).
- La réalisation d'une cartographie végétale sur les plantes envahissantes aux Comores.
- Bonne location de l'envahissement, bon contrôle de l'extension.
- Restauration écologique des habitats indigènes.
- Eviter l'envahissement par les espèces exogènes, protéger les sols contre l'érosion.
- Développement d'un système de détection et de suivi des impacts des plantes envahissantes.
- Meilleure maîtrise du danger pour des réactions appropriées.
- Le développement des mesures compensatoires aux communautés qui seront directement affectées par les actions d'éradication des plantes envahissantes utiles chez eux : les communautés locales sont très familières à certaines plantes qui leur fournissent des revenus non négligeables pour la survie de leurs familles.
- Le développement d'un partenariat régional franc pour l'échange d'expérience et la mobilisation des ressources financières nécessaires: l'échange des expériences de terrain est une priorité pour une meilleure maîtrise des leçons apprises les uns des autres en vue d'une solution très appropriée. L'établissement des programmes de mobilisation des ressources financières au bénéfice de toute la région pourrait

favoriser les différentes actions de recherches et d'éradication de l'envahissement dans l'ensemble des îles, surtout les plus démunis.

Rapport d'un projet sur l'Atelier regional sur la lutte contre les espèces exotiques envahissantes et la réhabilitation des îlots et les sites terrestres de grands intérêts écologiques

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Introduction :

Objectif

- Inventaire floristique
- Inventaire faunistique
- Reconnaissances des espèces exotiques envahissantes
- Réhabilitation de sites à grande valeur écologique.

Anjouan

Anjouan, la seconde des îles Comores a une superficie de 424 km² a la forme générale d'un triangle. Le pic du Mont Ntringui site de grande valeur écologique a un sommet de 1595m. Il y a 22km du centre à l'extrémité de pointe de Nyumakélé, 25km de pointe de Sima et 17km à l'extrémité de Jimilimé. De pointe en pointe, il y a respectivement 40km, 30km et 35km. Le plus haut sommet n'est qu'à 7km de la mer.

Sur le Mont Ntringui, il existe une réelle situation d'urgence, tant sur le plan écologique que sur le plan social.

En effet, outre les problèmes domestiques et alimentations quotidiennes que peuvent provoquer le manque de bois de feu et la baisse de rendement agricole.

Cependant l'île connaît une forte pression démographique avec une densité de la population de 550/km², pour cela les conditions climatiques ont réduit la période pluvieuse et une valorisation des espèces exotiques et même autochtone de notre île.

La déforestation a atteint un seuil critique et depuis ces dernières années les indicateurs de la dégradation consécutives sont particulièrement visibles.

- Assèchement des rivières.
- Diminution de la fertilité du sol.
- Apparition des espèces incultes (padza).
- Envasement des rivières et des littoraux.
- Disparition des espèces floristiques et faunistiques à caractères d'endémisme.

2. La végétation

Au Mont Ntringui particulièrement au niveau de l'île, la végétation est constituée de quelques lambeaux de forêt naturelle où l'on trouve des espèces locales telle que *Khaya comoriensis* (MPORI), *Brachylaena ramiflora* (MSHELELE), *Weinmania comoriensis* (MKINDRIKINDRA), *Chysohyllum* sp. (MFWENTSY), *Ocotea comoriensis*

(MROBWE), *Tabourisa* sp. (MBOMO), *Nuxia pseudodentata* (MWAHA), *Anthocleista grandiflora* (MPAPA), *Ficus lutea* (MVOUVOU), etc.

Par ailleurs, la végétation n'est constituée que d'adventices à base de Graminées, Cyperacées et même d'espèces introduites.

En effet, certaines espèces introduites ne sont plus contrôlées et elles sont devenues indésirables et envahissantes dans le champ. Il y en a ainsi :

Psidium Guajava

Psidium cattleianum Pwera songoma

Lantana camara Mboisera

Litsea glutinosa Mzavoula kamaro

Calophyllum inophyllum Mkora

Acacia auriculiformis Boenisite

Clidemia hirta Dessirée

Agave sisalana Moukitané

L'exploitation anarchique et illicite de l'espèce, ainsi que l'introduction au cours des siècles des nombreuses espèces exotiques mettent en danger les espèces indigènes endémiques et les associations végétales.

3. Les données faunistiques du Mont Ntringui sont menacées et incomplètes. La faune est diversifiée et déséquilibrée.

Bien que pauvre en mammifère, tous les groupes zoologiques sont représentés. D'après les chercheurs, on a recensé et on compte actuellement une centaine d'espèce d'oiseaux dont 60 espèces nicheuses et 39 espèces migratrices.

Les connaissances sur les insectes sont fragmentaires et méritent d'être approfondies. Les reptiles (serpents et lézards), 10 espèces endémiques.

Les oiseaux, on compte 13 espèces forestières et 23 sous espèces parmi les espèces 7 sont endémiques.

On recense aussi des rats et des chats sauvages.

4. Consistance politique

Elle consiste à une campagne de sensibilisation impliquant tous les acteurs soit à une destruction des espèces envahissantes soit à une régénération de ces espèces dans les zones considérées.

Autorité locale en l'occurrence, mairie, gendarmerie, garde forestier, ONG, association population pour l'environnement et la protection de l'environnement ;

Une méthodologie de travail sur les opérations de la végétation autochtone et exotique sera établie entre les acteurs selon la spécificité de chaque région.

4. Réhabilitation :

- Inventaire floristique (exotique et envahissante).
- Inventaire faunistique.
- Délimitation du site Mont Ntringui.
- Protection en haute altitude et moyen altitude avec la réhabilitation des espèces locales adaptés.
- En base altitude, au niveau du Lac Dzialandzé, nous exigeons une protection intégrale avec l'introduction des espèces qui ne vont pas pomper l'eau.
- Au niveau de Mont Ntringui vers l'ouest au pied du Mont Ntringui, la forêt de Moya et à l'est, la forêt du col de Patsi sont sollicitées à un reboisement.
- Un projet d'un arboretum est au cours. Le gouvernement de l'île autonome d'Anjouan, nous a promis de nous valider le site Mawana colé, du CEA de Ongoni (Centre d'Encadrement Agricole de Ongoni) pour la réalisation de nos rêves.

International and Regional Cooperation on Invasive Alien Species

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Introduction

The need for cooperation to address the global threat of invasive alien species (IAS) has long been recognised. Calls for collaborative work are increasing and we are seeing more and more cooperative programmes/initiatives on the ground. Programmes described in this paper are examples of international and regional cooperative efforts dealing with the IAS problem.

The purpose of this paper is to acquaint the participants with these programmes and explore their relevance to the western Indian Ocean islands.

The South Pacific Environment Programme (SPREP)

Established in 1982, SPREP is an inter-governmental organisation operating under the 26-country signatory of SPREP Agreement that entered into force in 1995. Member countries include 22 Pacific Island countries, states and territories, together with France, United States of America, Australia and New Zealand. Funding for the programme is mainly from Member contributions and donors.

SPREP's mission is: *To promote cooperation in the South Pacific region and to provide assistance to protect and improve its environment and to ensure sustainable development for present and future generations.*

Invasive alien species are a major threat to the native fauna and flora of the Pacific islands (Sherley, 2000). They are responsible for a number of species extinctions and they threaten many more. The realisation by Pacific countries of the severity of the IAS problem in the region resulted in the creation of a Regional Invasive Species Programme to be managed by SPREP. The programme, which was initially funded by the New Zealand government, is now in its sixth year and spearheads SPREP's work on IAS.

A resounding achievement of the Regional Invasive Species Programme was the development of a regional invasive species strategy for the Pacific Islands (Sherley, 2000). The strategy was produced collaboratively by the Pacific countries and endorsed by them all in 2000. Components of the regional strategy include information, awareness, infrastructure, protocols, legislation and funding. Key impediments were identified for each component and measures necessary to overcome these were outlined. Technical reviews of terrestrial and freshwater IAS that threaten biodiversity were completed prior to the production of the strategy and published in the same publication.

In addition to coordinating the implementation of the strategy, SPREP is engaged in a number of IAS activities including the development and implementation of a training course held in-country to strengthen border control capacity for invasive species; securing funding for the eradication of the newly introduced common myna (*Acridotheres tristis*) in Kiribati; endangered species protection by predator control and ecotourism development in the Takitumu Conservation Area in the Cook Islands, and rodent eradication and island restoration of Aleipata Islands in Samoa.

The marine invasive species threat is addressed under the Pacific Ocean Pollution Prevention Programme (PACPOL). Funding has been secured from the International Maritime Organisation (IMO) to develop a Regional Invasive Marine Species for the Pacific Islands, which will complement the overall IAS Strategy. It will cover legislation and policy, management practices, risk assessment, baseline surveys, monitoring and training.

The Global Invasive Species Programme (GISP)

The GISP was established in 1997 as a partnership between the Scientific Committee on Problems of the Environment (SCOPE), the World Conservation Union (IUCN) and the Centre for Agricultural and Bioscience International (CABI) to address the global threats of IAS. Its mission is: *To conserve biodiversity and sustain human livelihoods by minimising the spread and impact of IAS.*

Activities undertaken during the first phase of the programme (Phase I, 1997 – 2000) resulted in the production of various volumes on topics relating to IAS and global change, human dimensions, vectors and pathways, economic perspectives; a global strategy on IAS; a toolkit of best prevention and management practices; a series of assessments of the global IAS problem and a database (www.issg.org/database).

The second phase of GISP (Phase II, 2001 – 2006) operates through a “Partnership Network” consisting of governments, intergovernmental and non-governmental organisations, academic institutions and the private sector. The network’s roles include raising awareness of the IAS problem and potential solutions at all levels, making IAS information readily available to a wide range of audiences (including policy maker, scientists, educators, etc.) and supporting partners in the design of IAS projects and programmes. The network also provides support to the GISP Working Groups.

Objectives the Programme has committed to during Phase II include: (1) promoting the implementation of Article 8 (h) of the Convention on Biological Diversity (CBD); (2) improving the scientific basis for decision-making; (3) supporting the review, development and strengthening of policy and legal instruments at all levels; (4) reducing economic impacts of IAS; (5) developing capacity for the management of IAS; (6) raising awareness of IAS issues at all levels and (7) promoting and facilitating access to and sharing of IAS information.

Anticipated information outputs during Phase II comprise best practice manuals for prevention, early warning and rapid response, funding agencies and aid organisations, a toolkit for IAS management on islands and an assessment of the socio-economic costs of IAS. GISP is also maintaining a website (www.gisp.org) and publishing a newsletter.

An important service provided by the GISP network is technical support to key stakeholders directly through collaborative projects and programmes and through partner organisations.

As part of its commitment to capacity development on IAS, GISP is developing a training course in IAS management based on existing training material and adapted to be used in various regions. The development of the best practice manuals and the training course will be closely linked, as this is the key to ensuring Best Practice procedures are consistently and effectively applied in the field.

The Cooperative Initiative on Invasive Alien Species on Islands (Cooperative Islands Initiative or CII)

Invasive alien species are now widely regarded as a major threat to biodiversity worldwide (McNeely *et al.*, 2001; Bright, 1998). Their impacts are immense, insidious and often irreversible - especially on islands. For example, IAS have been directly implicated in at least 55% of historical bird extinctions on islands (King, 1985). Although islands are more vulnerable to invasions and more likely to suffer catastrophic loss of biodiversity, they also present special opportunities for preventing new introductions and eradicating existing invasive species.

GISP Phase I Synthesis Conference held September 2000 in Cape Town, Republic of South Africa identified islands as a special case warranting cooperative initiatives and the CBD has repeatedly recognised the very urgent need to deal with IAS in isolated and vulnerable ecosystems (Decision V/8 (8 and 13) of the fifth meeting of the Conference of the Parties (COP 5) to the CBD and Preamble of Decision VI/23 of the sixth meeting of the Conference of the Parties (COP 6) to the CBD). Island nations that currently lack expertise, or have limited access to technology to deal with IAS, should be able to draw upon existing, successful IAS programmes from elsewhere through international and regional cooperation. Experience gained on islands should be shared between island countries and countries with islands.

Within this framework the idea of the Cooperative Islands Initiative was developed at the sixth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA 6) of the CBD held in March 2001. The representatives of island countries and others who were present at the meeting unanimously endorsed the idea. This initiative was developed by New Zealand, the IUCN Invasive Species Specialist Group (ISSG) under the umbrella of GISP. The sixth meeting of the Conference of the Parties (COP 6) to the CBD endorsed the Initiative and called on the Global Environment Facility (GEF), Parties to the CBD, other Governments and relevant organisations to support and

participate in the initiative. The CII is hosted and coordinated by the ISSG and started in June 2002.

CII's mission is: CII's mission is: *To reduce IAS threats to island ecosystems globally and the native species they contain by increasing awareness of alien invasions and of ways to prevent, control or eradicate them and to promote and facilitate the development of regional and national capacity to effectively manage invasive alien species on islands.*

As indicated by its title, islands are the focus of the initiative. Although, initially the initiative is concentrating on the Pacific region, it is global in scope. Efforts are already being made to broaden the initiative beyond the Pacific. The CII addresses IAS threats to both terrestrial and aquatic ecosystems, the species they contain and the livelihoods they support.

Since its inception, CII has attracted interest from a wide array of organisations and programmes. As a result, partnerships are being forged (see slide: CII – Partners) and avenues for cooperative work are being widely explored. Avoiding duplication and identifying opportunities for synergies and complementarity are high priorities of the initiative. The CII's Strategic Plan is currently being finalised.

The CII is committed to raising awareness of IAS and their management; collating and disseminating information on IAS through the Global Invasive Species Database (www.issg.org/database), the ISSG newsletter *Aliens*, Aliens-L listserver and technical publications (Veitch and Clout, 2002); providing technical support to programmes (including training programmes); facilitating “demonstration projects”, skills sharing and peer review; promoting cooperation; and supporting and fostering partnerships. The “demonstration projects” will be important in raising awareness and enhancing support for IAS management on islands. Criteria for selecting “demonstration projects” under the CII include: (i) important anticipated biodiversity outcomes, (ii) technically achievable, (iii) use and contribute to the development of novel techniques and approaches, and (iv) political and community support.

Examples of projects that CII is currently contributing to:

- UNESCO-funded feasibility study on the eradication and control of a suite of invasive mammals and plants on Cocos Island, Costa Rica. CII had input into the proposal and is now facilitating the planning stages (including the identification and securing of the team of experts to lead the work).
- Feasibility study on the eradication of the crazy ant (*Anoplolepis gracilipes*) on Tokelau. CII is presently engaged in securing funding for the study from NZAID.
- SPREP-led training course on invasive species prevention. CII developed core components of the training and had extensive input into the pilots. The US Fish and Wildlife Service funded the course.
- Pacific Ant Prevention Plan. ISSG under the aegis of CII has initiated and facilitated the meeting to develop the prevention plan for the red imported fire ant (RIFA) (*Solenopsis invicta*) and other invasive ants for the Pacific region. It is now coordinating efforts to have the plan endorsed by countries of the Pacific region and progress its implementation.

- Expert input to project proposals and operational plans. CII had direct inputs and facilitated inputs from ISSG members and from the New Zealand Department of Conservation to the SPREP-led plan for rodent eradication on Aleipata Islands, Samoa.
- Support to and securing of funding for partnership programmes and projects. ISSG/CII had inputs to the PDF (A&B) stages of the SPREP-led IAS programme funded by GEF and in partnership with ISSG/CII and BirdLife.

Relevance to the western Indian Ocean islands

The IAS problem is huge both in scope and scale and necessitates a lot of expertise and resources to address it. Generally, countries particularly, developing countries (including small island developing states) do not possess the necessary expertise or resources to fight IAS. Therefore, it is imperative that these countries are able to learn and share the lessons learned elsewhere through international and regional cooperation. On the national level, government agencies, conservation organisations, communities and other relevant stakeholder groups must also cooperate to stem the tide of IAS. Indeed, cooperation is needed at all levels to address the IAS threat to biodiversity and livelihoods. The programmes outlined above have demonstrated that cooperation is a must and need to be promoted and facilitated whenever possible. The distribution of IAS expertise is uneven across the islands of the western Indian Ocean and therefore there is no doubt that they would extremely benefit from cooperating with each other.

A regional IAS programme modelled on the SPREP Regional Invasive Species programme is directly applicable to the western Indian Ocean region. Countries in both the Pacific and western Indian regions are Small Island Developing States, suffer from various IAS problems, have insufficient IAS expertise and resources (funding and people). Strategically, the Indian Ocean Commission would be the natural body for coordinating such a programme. The CII would support and contribute to the creation of such a programme, as this would be consistent with its mandate.

Western Indian Ocean islands will benefit greatly from interaction and involvement with GISP at both a national and regional level. GISP has been established to assist developing countries in addressing their IAS problems. In addition, IAS on islands is presently a key topic within GISP. Having the GISP Secretariat currently located within the region in Cape Town should only serve to encourage such interaction.

Finally, western Indian Ocean islands are invited to call upon the Cooperative Islands Initiative for its support and input to IAS programmes/projects. As mentioned above it is a global initiative, solely focusing on IAS problems on islands and as such would welcome partnering with and contributing to efforts to prevent and manage IAS on the islands of the western Indian Ocean.

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

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Abstract

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.

Introduction & 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 mainstreaming of IAS 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 and 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 (see endnote this volume). To maintain recent momentum it is imperative that existing efforts are scaled up (Mauremootoo *et al.* in press). 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 it 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).

IAS 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 wide-spreading 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 (Payendee this volume) 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 IOC 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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Field trip to Mare aux Cochons (Mahé) a mainland site where restoration work has been carried out

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Introduction

The following is edited from the handout given to workshop participants before they visited the Mare aux Cochons site. It contains information on the restored sites and the results achieved.

History of site

- The Mare aux Cochons area was already owned by the first settlers of the island in the 1800s'.
- After the abolition of slavery, most of them left and the properties were bought by the catholic mission.
- Cinnamon cropping and oil distillation then became the main activity within the area (Seychelles production represented up to 70% of the world production)
- With competition from south-east Asia and drop in prices, the activity stopped (1970s').
- The area was then invaded by exotics such as cinnamon (*Cinnamomum verum*), jambrosa (*Syzygium jambos*), coco plum (*Chrysobalanus icaco*) and the fern (*Dicranopteris linearis*), the latter of which is a native pantropical species.

Habitat Restoration project

- A pilot project was initiated in 1998.
- This covered an area of 2.25 ha. at plateau Belize (400m alt) found within the boundaries of the National Park.
- 1200 endemic plants ranging from species critically endangered to not threatened were replanted (e.g. *Gastonia lionnetii*, *Vateriopsis sechellarum*, *Pittosporum senacia*, *Phoenicophorium borsigianum*)
- The area to be treated was either cleared of all existing exotics or the canopy was trimmed.
- Exotics were burnt or laid down as anti erosion barriers.
- The existing endemics such as Bois Rouge (*Dillenia ferruginea*), Bois Calou (*Memecylon eleagni*) and Latanier Palmiste (*Deckenia nobilis*) were kept.
- Two types of plant materials were used :
 - (i) plants from the nursery with fully developed root system in undersized pot,
 - (ii) bare rooted palms found in the forest around (growing too densely or too close to a path).
- Plants were transported by truck, dumper, or airlifted
- The National Park Unit of the forestry section undertook the work. (1 supervisor & 8 field workers).

Lessons Learnt

- In terms of growth rate, fully rooted palms are 1.5 to 2 times higher than bare rooted palms after 5 years of experiments.
- Planting under the exotic canopy is more successful than on cleared site (Growth rate 2.5 times higher).
- The endemics take longer to adapt and their growth rate is up to 10 times slower than those of invasive species.
- A comprehensive assessment of the site is needed prior to restoration work to choose appropriate species for replanting.
- After the removal of the invasive species it is necessary to start replanting schemes without delay to avoid germination of exotics from the seed bank and increased cost of restoration.
- Possible practice seems to be to remove exotics during the dry season when growth rates are lower and plan the replanting during the rainy season. This reduces restoration costs considerably since maintenance efforts can be reduced.
- Coordination between plant propagation and reintroduction is crucial to avoid high nursery costs and to achieve best success rates in reintroduction schemes. Over-aged seedlings (>1 year old) have difficulties in adapting and their growth rate is 1.5 less compared to the others.
- Costs of restoration is high in uplands : approximately 50,000 US\$ per ha. excluding propagation cost. Labour cost is very high (around 30,000 US\$ per ha).
- To reduce restoration costs especially of upland habitats where transport distances are considerable, direct sowing of seeds could be practiced.
- Temporary nurseries in restored areas may reduce cost.
- As a general rule upland restoration work involving total clearing and replanting demands the following time schedule : 37% preparation of site, 30% transportation of plants, 12% digging of holes and 21% distribution of plants and planting.

Main shortcomings

- Lack of continuity.
- Lack of funding so that such similar small projects can be developed.

Ideas for the future

- The area could be extended further with more funding by having an annual target.
- Similar projects should be done in areas where it is more visual so that benefit can be seen and appreciated, thus promoting awareness.

Habitat restoration of intermediate secondary cinnamon forests in the Seychelles. Reflections from a field excursion.

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Abstract

This article summarises the discussions undertaken at Belize in the Mare aux Cochons valley during a field excursion through the Morne Seychellois National Park on Mahé. The different habitat types encountered during the excursion are described and their potential for habitat rehabilitation is discussed.

It is argued that it is fruitful to base a habitat rehabilitation strategy on the specific opportunities/potential and risks a particular habitat or site offers.

The context-dependent opportunities and risks for habitat rehabilitation are discussed for the case of the intermediate secondary cinnamon forests on Mahé.

As a promising strategy the management of propagule pressure, i.e. seed rain, on the landscape scale is introduced. Patches of native vegetation can be restored in the landscape to function as ‘nascent foci’ for the re-colonisation of the surrounding forests.

The article closes with a vision of a habitat rehabilitation strategy that is based on a combination of cheap small-scale interventions that support the natural recovery of the intermediate secondary cinnamon forests of Mahé.

Introduction

This article summarises discussions undertaken in Belize regarding habitat restoration in the Mare aux Cochons valley during a field excursion through the Morne Seychellois National Park on Mahé.

Belize is a plateau of a few hectares on approximately 400 m asl.. at the beginning of the Mare aux Cochons valley that leads through the centre of the Morne Seychellois National Park. Most of the plateau has been recently replanted with five endemic palm species as well as some native woody species. The Mare aux Cochons valley allows an appreciation of the typical habitats of the National Park, their history of human disturbance and the potential for habitat rehabilitation.

The landscape, habitats and vegetation of the Morne Seychellois National Park are summarised in the following section. These descriptions help to illustrate several points relating to habitat restoration of the intermediate secondary cinnamon forests that are Developed in more detail in the subsequent text.

From the outset it is essential to add a note of caution. The arguments presented in this article represent personal preliminary reflections that are not substantiated by quantitative data. Rather they are based on observations made in the research project of the

Geobotanical Institute in collaboration with the Forestry and National Park Section (Kueffer *et al.* 2003a, Schumacher *et al.* 2003). It is my conviction that anecdotal field observations can often be as important as quantitative data for the innovation of effective management practices. A relevant aspect of a regional network such as the one discussed in this workshop is that it allows the oral exchange of anecdotal knowledge between experts and the personal encounter of the concrete situation in the field.

Habitats encountered during the field excursion

On the way to Belize we first passed through a plantation forest of timber trees such as Mahogany *Swietenia macrophylla*, Santol *Sandoricum koetjape* and Agati *Adenanthera pavonina*. Plantations, either abandoned or still exploited on a small scale, characterise the lowland forests between c. 100 and 400 m asl. on Mahé. In between we encountered open shrubby areas dominated by the invasive Prune de France *Chrysobalanus icaco*. The visible red laterite soil indicates that the topsoil has almost completely eroded. *C. icaco* has been frequently used for erosion control in the past, often after forest fires. Bois jaune *Alstonia macrophylla* is an invasive tree that copes well with the shallow, poor soil of this habitat. Several native *Ficus* species, one native *Euphorbia* species and some common natives shrubs such as Bois calou *Memecylon eleagni* or Café marron grande feuille *Paragenipa wrightii* can be found scattered between the *Chrysobalanus*. New invasive shrubs such as *Memecylon caeruleum* or *Dillenia suffruticosa* build up their population sizes in these heavily disturbed sites.

After the steep walk through the plantation forest we ended up in a flatter area where we found ruins of a former cinnamon distillery. During the 19th century almost all, if not all, native forests on Mahé were cut down. Paintings of the 19th century artist Marianne North show large areas within today's National Park without any forest left. Cinnamon *Cinnamomum verum* colonized the land and formed an exotic, secondary forest. At the beginning of the 20th century an extremely fast exploitation of this naturally grown cinnamon began. Within c. 10 years most big cinnamon trees were exploited, and the cinnamon industry had to move from cinnamon bark to leaf oil production. Oil distilleries used large amounts of firewood. The cinnamon oil production led to a second almost complete deforestation of Mahé in the first half of the 20th century. The lowland forests were replanted with timber trees, while the intermediate forests above c. 400 m asl. regenerated as cinnamon forests. After the opening of the international airport in 1971 and the start of a large-scale tourism industry, the cinnamon industry almost completely collapsed.

Therefore, the habitat in the Mare aux Cochons valley we passed through from the old distillery and the nearby Belize plateau to almost the end of the walk at the Sans Souci road, is a secondary cinnamon forest that emerged during the 19th century and was intensively exploited for approximately 50-60 years from c. 1905 to the 1960s/1970s. It is the typical habitat on an intermediate altitude between c. 400 and 600 m asl.

Belize is surrounded by ridges and hilltops of 500-900 m asl. On many ridges and hilltops open granitic rocks with a sparse vegetation of shrubs, pandans and grasses occur rather than the forest canopy found elsewhere. These are the so-called inselbergs or glacis

(Fleischmann *et al.* 1996, Biedinger and Fleischmann 2000). Inselbergs are now the habitats with the highest endemism and the lowest percentage of exotic plants on Mahé.

The areas above c. 700 m asl. are regularly covered in clouds. In these altitudes the mountain forests with its mosses, ferns and a small, specialised endemic flora and fauna can be found.

Reflections on forest restoration related to the field excursion

The ultimate goal of any invasive species management is to conserve and restore habitats suitable for the native flora and fauna (habitat rehabilitation or restoration). The focus should, therefore, be on restoring self-sustaining ecosystem processes. Habitat rehabilitation should consider the landscape scale. Small, intensively managed areas have to play their ecological role in the forest of which they are part.

Small oceanic islands have experienced heavy human disturbances in their recent past. The starting points for habitat rehabilitation therefore are very particular, context-dependent ecosystem states shaped by their specific past histories. Rather than guiding research and management by the vision of a former pristine nature, the focus should be on the particular opportunities and risks each individual habitat or site presents for management, i.e. a case study approach (Shrader-Frechette and McCoy 1993).

Buffer zone management

The control of the spread of invasive species is not discussed in this article specifically. One habitat management approach with the aim of reducing the spread of problematic species is the buffer zone concept. The areas surrounding biodiversity hotspots can be valuable for nature conservation even if they themselves are not of high biodiversity value. If they provide unsuitable habitat for invasive species they may act as barriers to invasions.

In this regard, the value of the endemic palm Latanier feuille *Phoenicophorium borsigianum* has been discussed in the Seychelles. *Phoenicophorium* is one of a few native species that regenerate frequently in plantation forests, such as the one we passed through on our way to Belize. The hope is, that a palm understorey will form a second layer below the canopy trees and reduce the regeneration of invasive species. Unfortunately, *Phoenicophorium* leaves are today still cropped in the wild for roof thatching.

The management of an effective buffer zone should focus on large openings that may function as step stones for invasions ('nascent foci' *sensu* Moody and Mack 1988). An example is the opening around the already mentioned former cinnamon distillery where problematic invasives such as Vielle fille *Lantana camara* or Faux vatouk *Clidemia hirta* build up propagule pressure and where exotic plants such as Diffenbachia *Diffenbachia seguine*, Bois Beurre *Pentadesma butyracea* or Jambrosa *Syzygium jambos* escape from a former garden

Opportunities/potential & risks for restoration in intermediate secondary cinnamon forests

In the following, I list opportunities and risks for habitat management that may characterize the specific case of the intermediate secondary cinnamon forests in the Seychelles. These forests are in an early stage of a secondary succession that started about 30-40 years ago from an exploited cinnamon forest.

Opportunities

Since the beginning of the unmanaged development of the habitat 30-40 years ago, presumably a forest canopy existed. Relatively low light levels prevented the invasion of the habitat by light demanding invasive species such as *Lantana camara*. The number of exotic species beside cinnamon and their abundance in this habitat is therefore low.

Root trenching experiments indicate that belowground competition is high. It can be assumed that this increases the resistance of the habitat to the colonization by new species (Davis *et al.* 2000, Kueffer *et al.* 2003a). However, it is not yet clear to what extent reduced availability of belowground resources has a differentially negative effect on invasive compared to native species, in the way availability of light does.

The recalcitrant nature of the cinnamon seeds assures that a long-lived soil seed bank does not develop.

When comparing the species composition of the adult and the juvenile life stages in these forests, interesting differences were found. The adult layer is almost completely dominated by cinnamon intermixed with a few endemic Capucin *Northea hornei* trees. In contrast the juvenile layer is composed of about 15 native and about 10 exotic species. The abundance of the native species is higher than the abundance of the exotic ones in the juvenile stage. Most remarkably, the abundance of cinnamon is low. Mortality of juvenile cinnamon must, therefore, be high. The cinnamon adult layer seems to function as a filter that benefits the native regeneration compared to the regeneration of cinnamon. The mechanisms behind this phenomenon are not yet understood. Several hypotheses can be formulated:

- Cinnamon needs relatively high light levels for regeneration. It is well adapted to colonize open areas, but not to regenerate under a closed canopy (tested in the research project of E. Schumacher, see also Fleischmann 1999).
- The frequently observed sudden dying of cinnamon saplings especially in the wet season indicates that a damping off effect (pathogens) might be involved.
- Intra-specific below-ground competition may be stronger than inter-specific competition

The observed species composition of the juvenile life stage indicates that seeds of several native species are regularly brought into the habitat by birds and fruit bats.

The demography of the adult trees is relatively homogenous and biased towards rather young trees. Gap formation through dying trees is therefore rare. This gives the native regeneration time to develop under a closed canopy. Gaps would generally

benefit invasive species. In some mountain forests in the Seychelles where adult cinnamon trees are older, frequent gap formation seems to hinder a native regeneration. In these gaps a rather dense, and mainly exotic juvenile layer can be found.

The former management of the forest preserved patches of native vegetation. Along rivers and in wetter areas either stands of palms dominated by *Latanier latte* *Verschaffeltia splendida* or patches of pandans can be found. The cinnamon forest is intermixed with stands of *Northea hornei*. To focus rehabilitation and weeding efforts on these remnants of native vegetation, even if only small patches remain, may not only be cheap, but it may also be argued to be in the line of the precautionary principle, that is in the absence of additional knowledge, the chances of preserving specialized native invertebrates are highest in these patches. Additionally, such patches may be conserving the last vestiges of the original ecosystem processes. In the research project of the Geobotanical Institute we use such remnant native vegetation as a reference state for nutrient cycling by comparing litter decomposition rates under it with decomposition rates under exotic stands.

Risks

One of the few generalizations made so far about tropical forest recoveries after human disturbances is that impacts on the soil component of the ecosystem (soil nutrient content, soil compacting etc.) are among the longest lasting (e.g. Chazdon 2003). Similarly, for invasive species it is often the case that ecosystem effects, especially on the soil system, remain even after the removal of the invasive species (Vitousek and Walker 1989, Zavaleta *et al.* 2001). In the Seychelles the N-fixing invasive tree *Albizia Paraserianthes falcataria* has the potential of altering nutrient cycling (Kueffer *et al.* 2003b). Additional less apparent mechanisms can also be expected. One such effect is that of exotic versus native litter with its supposed differences in the leaf chemistry on litter decomposition rates and nutrient cycling, an area the research project of the Geobotanical Institute is currently investigating.

The enemy release hypothesis (Keane and Crawley 2002) states that native herbivores preferentially attack native species, and that invasive species therefore profit from the release from natural enemies. If true, this implies that exotic dominated forests are relatively poor habitat for native herbivores. I found support for the proposed hypothesis in cinnamon forests by counting attacked leaves per plant, and the degree of herbivory per leaf. The percentage of attacked leaves was about double among the native compared to the exotic species. However, differences within groups between species were large, and cinnamon was the exotic species that showed by far the highest herbivory rates. Herbivory on cinnamon was almost equal to the mean of the native species. However, the method used was very simple and difficult to interpret, and these results should therefore be interpreted with caution.

Exotic rats are very abundant in the cinnamon forests and apparently predate heavily on the large seeds of *Northea hornei*, the most abundant remaining endemic tree. This may partly explain the low regeneration of this species. On the other hand, rats also predate

very significantly on seeds of invasive species such as *Chrysobalanus icaco* and increase the resistance of the habitat to invasions of this species.

Landscape Perspective: Propagule Pressure

As mentioned in the last paragraph, the regeneration in the intermediate cinnamon forests seems to be driven by an influx of seeds of native and exotic species that are currently not represented in the adult layer. The technical term that is used for the contribution of seed rain to invasion, or more generally colonisation, processes is propagule pressure (Williamson 1996). In the following I shortly discuss how a closer look at propagule pressure, i.e. seed production, dispersal and germination, can inspire habitat rehabilitation. Propagule pressure processes take place on the landscape scale. For the recovery of disturbed tropical forests in general, it has been shown that the landscape matrix and the proximity of remnant (native) forest patches play a critical role (Chazdon 2003).

For the control of the spread of invasive species the concept of ‘nascent foci’ (Moody and Mack 1988) has proved to be central (Mack and Lonsdale 2002). It is assumed that the spatial spread of an invasive species is considerably accelerated through widely dispersed small patches or single individuals. They function as stepping-stones in the landscape. Invasions from many different starting points are faster than single front invasions. An efficient control of invasive species should therefore prioritise the eradication of such starting points or ‘nascent foci’ (Mack and Lonsdale 2002). Using an analogous argument, a strategy for habitat rehabilitation may be to restore patches of native vegetation that serve as ‘nascent foci’ for the re-colonization of the surrounding forests. For instance, the small Belize restoration site may function as such a ‘nascent foci’ in the future.

For the Seychelles, I hypothesize that Inselbergs (Fleischmann *et al.* 1996, Biedinger and Fleischmann 2000) serve as seed sources. Next year we plan within the research project of the Geobotanical Institute to study the habitat use of frugivores (blue pigeon, bulbul, mynah, fruit bats), their fruit preferences, and the fruit production on inselbergs to test this hypothesis.

If the dispersal of fruits from inselbergs to the surrounding forest proves relevant, more detailed hypotheses could be tested to advise habitat rehabilitation by propagule pressure management on the landscape scale.

To improve the seed sources, weed management of inselbergs could be prioritised. Based on recent research that shows that bird fruit preferences are more guided by the general vegetation composition and the momentary abundance of fruits than by the species identity of the fruit tree (e.g. Sarocco 2001), it can be hypothesized that exotic and native plant species generally compete for seed dispersers, and that a reduction of the abundance of exotic species might increase seed dispersal of native species. On the other hand, it might also be that large cinnamon fruit sources attract frugivores to inselbergs, and thereby increase dispersal of native species.

To improve the dispersal of seeds to specific sites (directed dispersal *sensu* Howe and Smallwood 1982), it has been discussed in the literature to install perching places for birds in areas where restoration efforts are being made (e.g. Holl 1998, Holl *et al.* 2000). In the Seychelles, blue pigeons can often be observed perching on isolated trees in open areas. Below trees used as roosts for fruit bats a high native seed rain can be expected.

Conclusions

In this article I have proposed strategies based on the specific opportunities and risks a particular site offers, as ways of scaling up habitat rehabilitation. A landscape perspective should help to coordinate cheap small-scale interventions that support the natural recovery of secondary forests. Important landscape elements mentioned are buffer zones, seed sources or ‘nascent foci’, and matrix forests that serve as nursery habitats for native species re-colonisation.

As far as possible the different measures taken should be combined with other activities in the forest. Through this mainstreaming strategy financial capacity can be increased.

According to my vision, our walk through the Mare aux Cochons valley may look as follows in a few years:

- The invasive *Alstonia macrophylla* trees growing in the eroded openings among the *Chrysobalanus* shrubs are cut for their timber and used for handicrafts (the potential of the *Alstonia* wood for furniture, handicrafts, etc. is currently being investigated in the Seychelles, P. Vos, pers. comm.). Native pioneer species such as Bois de reinette *Dodonaea viscosa*, Bois joli coeur *Pittosporum senacia* subsp. *wrightii*, or Bois pomme *Syzygium wrightii* replace *Chrysobalanus* along the trail and are thereby tested as potential native alternatives for the rehabilitation of these heavily eroded sites.
- In the plantation forests, a dense native palm understorey has developed naturally.
- The opening around the former cinnamon distillery is managed as a tourist attraction. The invasive species growing in the area are thereby regularly cleared. The traditional way of producing cinnamon oil is presented in a small distillery that produces small quantities of luxury cinnamon oil sold to tourists together with the *Alstonia* handicrafts. With the generated money the gaps opened through the cinnamon cropping are replanted with endemics (Zemp 2003).
- The Belize plateau forms a small patch of native vegetation dominated by palms and functions as a ‘nascent foci’ for the native re-colonization.
- In the cinnamon matrix forest a mainly native juvenile layer has developed and some native adults already form part of the canopy.
- Inselbergs, such as Glacis d’Antin, as well as the pandans, palm and *Northea* stands along the trail have been weeded and are now almost completely composed of native species.
- The mahogany plantation at the end of the trail before reaching the Sans Souci road has been converted to a mixed plantation of mahogany and native timber trees such as Bois de natte *Mimusops sechellarum*.
- For the trail through the Mare aux Cochons valley from Le Niol to the Sans Souci road guided tourist tours are on offer. Within one day a wide range of native

species and habitats, as well as glimpses of the history of the Seychelles are presented and explained.

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Cousin Island Special Reserve, Republic of Seychelles

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Introduction

Cousin Island is a granitic island covering 27 hectares and lies approximately 2km from Praslin island, the second largest granitic island in the Seychelles archipelago. Formerly a coconut plantation, the island was made a Nature Reserve when it was purchased in 1968 by Birdlife International. In 1974 it was designated a Special Reserve. In 1998 Nature Seychelles, a local non-profit organisation, registered under the Laws of Seychelles, took over the management of the island.

The main aims of Cousin Island Special Reserve are to:

- Improve the island's biodiversity
- Improve understanding of island ecology
- Provide visitors with a unique experience
- Provide training and employment for the local population

Cousin Island attracts some 10,000 visitors a year and also caters for local educational groups and other residents. It remains one of the few islands in the world free of dogs, cats, rats and mice, a cause of the demise of the native fauna on other islands.

The island is open to visitors four days a week (Tuesday to Friday) and visitors can enjoy guided tours, which last approximately one hour and a half. Visitors pay an entry fee of \$25 but entry to locals is free. There is no restaurant or overnight accommodation but visitors can buy soft drink and souvenirs.

Visitor fees and donations sustain the management of the reserve as well as research, conservation and education projects both on and off the Reserve. Management of the Reserve has, since 1984, been undertaken entirely by locals based on the island.

What is special about Cousin Island?

Cousin is a wilderness area, being the first granitic island of the Seychelles to be almost totally rehabilitated with natural vegetation. Over a period of 30 years of conservation, the previous coconut plantation has disappeared and has been replaced by native vegetation comprising predominantly *Pisonia* (*Pisonia grandis*), *Morinda* (*Morinda citrifolia*) and *Ochrosia* (*Ochrosia oppositifolia*).

Cousin is the most important nesting site in the Western Indian Ocean for hawksbill turtles (*Eretmochelys imbricata*) and also hosts the world's longest running monitoring programme for this species. It boasts a number of other reptiles such as giant tortoises and five lizards endemic to the Seychelles – the Seychelles skink (*Mabuya seychellensis*), Wright's skink (*Mabuya wrightii*), the Bronze-eyed gecko (*Ailuronyx seychellensis*), the burrowing skink (*Pamelaescincus gardineri*), and green gecko (*Phelsuma astriata*).

Recorded reptile densities are amongst the highest in the world. On Cousin you will also find some of the world's longest millipedes (*Seychelliptus seychellarum*) and many hermit crabs (*Coenobita rugosus* & *C. brevipanus*) roaming the plateau.

Five of Seychelles eleven endemic land birds are found on Cousin. They include the Seychelles magpie robin (*Copsychus seychellarum*), Seychelles sunbird (*Nectarinia dussumieri*), Seychelles fody (*Foudia seychellarum*), the Seychelles blue pigeon (*Alectroenas pulcherrima*) and the Seychelles warbler (*Acrocephalus seychellensis*), the most endangered bird in the Seychelles. Cousin is the site of two of the world's great conservation success stories. Once the rarest bird in the world and found only on Cousin, the Seychelles warbler has increased in numbers by more than 1000% owing to conservation measures. The Seychelles magpie robin was previously found only on Fregate island and on the brink of extinction. Cousin was the only other site at the time where it could be transferred to increase the population. The new population thrived proving that the bird could be saved by translocation to other suitable islands.

Seven species of nesting seabirds occur on the island with total numbers exceeding 200,000 individuals. Fairy terns (*Gygis alba*) and white tailed tropic birds (*Phaethon lepturus*) nest all year round; lesser noddies (*Anous tenuirostris*) and brown noddies (*Anous stolidus*) nest in the South-East Monsoon (April- October); bridled terns (*Sterna anaethetus*) have a nine month breeding cycle. Two varieties of shearwaters, Audubon's shearwater (*Puffinus Ilherminieri*) and the wedge-tailed shearwaters (*Puffinus pacificus*) are found on the island. A recent census was undertaken to determine their total numbers and the population was estimated at 10-14,000 wedge-tailed shearwaters and some 10,000 Audubon shearwaters. The latter breed all year round.

The Special Reserve area also includes the surrounding marine area up to 400m offshore. Comparative studies have revealed that Cousin's reefs have the highest fish biomass compared to reefs in other marine protected areas in the granitic islands of Seychelles as well as harboring endangered fish such as the humphead parrotfish (*Bolbometopon muricatum*), a favorite of Asian fishers.

Management

Today Cousin continues to be managed by an all-Seychellois team of young men and women who stay on site. The aim is to keep Cousin Island free of development and totally reserved for conservation. The management policy is low key, research-oriented, and non-interventionist with the principal aim being the protection of globally-threatened species and education. All energy is supplied by solar power. Water is pumped from a well as well as caught from rain. Solid waste is taken to a sanitary land fill on Praslin. Flush toilets are not used on Cousin in order to save water and to prevent huge volumes of wastewater from accumulating in the ground.

Sustainable tourism

Ecotourism started on Cousin in 1970 and has continued uninterrupted since then. The aim is to make people aware of the rich biodiversity of the islands as well as to excite them about conservation. A suite of controls and practices serve to manage the impacts of

tourism. They include open and closed days, landing by Reserve boat only to minimise the risk of accidental mammal introductions, strictly controlled opening times, guiding by Reserve Wardens only, legislation protecting the biodiversity, mooring buoys to protect reefs from anchor damage, sale of tickets by the management authority only and so forth.

Regular monitoring of key species by scientists and wardens is undertaken to ensure that any disturbance would be noticed and mitigation measures taken. To promote high quality tourism, Cousin Island has since last year adopted a Tourism Code of Ethics for visitors urging them to adhere to both local and international regulations. Continuous attention is paid to Reserve facilities to ensure that tourism expectations are met.

The management and maintenance of the reserve are supported by visitors' fees, whilst ensuring that local communities enjoy benefits too. The revenue collected by the management authority (Nature Seychelles) is ploughed back into conservation programmes including research, species and habitat conservation, education and awareness programmes and advocacy. Seychellois are encouraged to visit the Reserve by making entrance free. Monday is reserved for school groups.

Cousin Island - a short recent history

Pre-1968: Cousin managed as a private plantation island. The entire plateau area is taken up with coconut palms – most planted since 1904. Native vegetation is restricted to inaccessible parts of the hill (*Pisonia grandis* forest, *Euphorbia pyrifolia* and *Pandanus balfourii* thickets), and the mangrove. In the 1920s or 1930s, Black-naped hares (*Lepus nigricollis*) were introduced from Mauritius and probably had some effect on the vegetation.

1968: Cousin purchased by ICBP (International Council for Bird Preservation, now BirdLife International) as a nature reserve, primarily because it holds the last remaining population of Seychelles Warblers *Acrocephalus sechellensis* (less than 30 birds, all in the mangrove), also one of three populations of Seychelles Fody *Foudia sechellarum*. It also holds important populations of breeding seabirds and hawksbill turtles although the importance of the site for these species is not immediately recognised. The site was declared a nature reserve, encompassing all land above the high water mark.

1970: First vegetation study, by F R Fosberg. First resident Scientific Administrator appointed.

1974: Cousin declared a 'Special Reserve' by the Seychelles government. Special reserve designation takes in surrounding sea to 400m offshore, to protect reefs and turtles.

1975: First management plan prepared, for period 1975-9.

1976: Independence of Seychelles from UK.

1984: All-Seychellois team of wardens take over management

1988: Seychelles warblers translocated from Cousin to Aride (also to Cousine 1990).

1994: Seychelles Magpie Robin moved to Cousin. Still the most endangered Seychelles Endemic bird.

1998: Nature Seychelles established, management of Cousin now coordinated locally.

1999: Survey of the vegetation by E. Schumacher and M. Wüthrich of ETH, Zurich. Permanent vegetation plots established.

2002: Seychelles Fody introduced to Aride from Cousin.

September 2002: Tropical storm causes extensive damage to *Pisonia grandis*, *Ficus reflexa* and *Ficus lutea* forest.

Vegetation management

There are no reliable records of the original vegetation of Cousin Island although it seems likely that *Pisonia* would have been present, as it thrives on guano-rich soils on seabird islands and in coastal zones exposed to salt spray (Fosberg, 1970). Trees forming an important part of coastal forests on the larger islands of Seychelles (e.g. *Calophyllum inophyllum*, *Terminalia catappa*) were unlikely to be important components of the Cousin woodland.

Today, the vegetation is very different from upland sites on the main islands. Only one endemic species is present, *Pandanus balfourii*, and the endemic subspecies of *Ficus reflexa*. Most of the vegetation is a species-poor community made up of a few native species, predominantly *Pisonia grandis*, *Morinda citrifolia* and *Ochrosia oppositifolia*.

The earliest management plan for the reserve recognised that management of endemic birds is best achieved through vegetation management. Vegetation management has rarely involved intensive intervention; initial attempts at planting coastal species for erosion prevention in 1968 and 1972 failed. Management consisted of collecting and exporting fallen coconuts to prevent their regeneration (and to contribute funds), and the periodic cutting of Rangoon Creeper *Quisqualis indica*; otherwise, vegetation management favoured natural regeneration. The cessation of intensive management of the coconut plantation caused the rapid growth of *Pisonia* and *Morinda*.

Mature coconuts were removed en masse in the 1980s, and coconut seedlings have been removed regularly and continue to be cut despite a great decrease in the number of mature fruiting palms surviving. Coconut crowns are a favourite nesting site for brown noddies and cutting of mature palms had to take place outside the breeding season (May-September).

Initially, there were concerns that the cessation of plantation management would lead to the decline of some of the alien plant species then being used by endemic bird species including papaya *Carica papaya* (fruits eaten by fody), castor bean plant *Ricinus communis* (seeds eaten by turtle dove) and herb serzan *Achyranthes aspera*. However, early research by Diamond showed that *Pisonia* and *Morinda*, the most strongly regenerating species, were the plants most commonly used by the insectivorous birds. While the maturing forest excludes many of these alien species, some are still present. Following the storm of 2002, many have increased in abundance and now need active control.

Giant tortoises were initially kept in a tortoise pen but numbers were augmented with animals brought in from Aride in the 1980s and they were later allowed to roam freely, probably contributing to the vegetation management. Present population is some 27 individuals. The role of hares in vegetation change remains unclear.

Cousin - Some useful References

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Annex 1: Seychelles IAS Workshop Schedule

Atelier régional sur les espèces exotiques envahissantes et la réhabilitation des écosystèmes terrestres dans les îles du Sud Ouest de l’Océan Indien

Partager les expériences, identifier les priorités régionales et définir un programme commun.

Atelier réalisé et financé sur les ressources du Programme Régional Environnement (PRE-COI) (N° comptable 7.ACP.RPR.068)

Introduction

La sauvegarde et la préservation des espèces végétales endémiques et des associations végétales menacées constituaient l’un des deux objectifs spécifiques du Programme Régional Environnement. Comme l’a très justement souligné le rapport d’évaluation du Programme, cet objectif fut progressivement délaissé au profit d’une concentration des activités vers la « gestion intégrée des zones côtières ».

Pourtant cette thématique intéresse directement les pays de l’Océan Indien qui, tous, se caractérisent par une flore au fort taux d’endémisme.

Ce sont les Seychelles qui ont approché la COI avec une proposition d’actions / projets futurs dans le domaine de la conservation de la flore et de la réhabilitation de sites de sites dégradés.

Le PRE arrivant en fin de financement, le programme sera définitivement clôturé en décembre, il n’était plus possible de démarrer des nouvelles activités dans ce domaine. Par contre, il a semblé utile d’organiser un atelier régional rassemblant des praticiens de la région, ainsi que quelques spécialistes internationaux de UICN, pour faire le point sur les expériences régionales en matière de réhabilitation de sites dégradés, avec une attention toute particulière pour la problématique des espèces exotiques envahissantes.

Il convient de signaler que la COI met en oeuvre, sur financement européen, un projet régional de protection des cultures (projet PRPV), qui traite des questions d’importation de matériel végétal et de quarantaine. La thématique des espèces exotiques envahissantes fait ainsi partie des préoccupations de la COI en matière de gestion durable des ressources naturelles.

Contexte

Les pays de la COI présentent une grande diversité de situations en matière de conservation des écosystèmes et, en conséquence, différents modèles de gestion des écosystèmes ont été expérimentés et mis en place dans les pays.

Annex 1: Seychelles IAS Workshop Schedule

D'un côté, les îles des Mascareignes (Maurice & Rodrigues, Réunion, les Seychelles) : la problématique des espèces exotiques envahissantes y est perçue comme un problème majeur menaçant directement la flore endémique.

De l'autre, les Comores et Madagascar où la déforestation constitue toujours un problème majeur.

Madagascar, île-continent, constitue un cas particulier, de par sa taille et ses priorités en matière de développement. Aussi a-t-il été proposé de focaliser l'atelier plus spécifiquement sur les petites îles : les îles des Mascareignes et les Comores. Madagascar sera cependant invité à prendre part, du fait des nombreuses petites îles et îlots à la périphérie de la Grande Ile.

Il convient cependant d'insister sur la nature « régionale » de cet atelier. Du fait de la nature très diverses des problèmes en matière de gestion des écosystèmes terrestres, il est indispensable de focaliser l'atelier sur un nombre restreint de questions communes à l'ensemble des participants, de façon à ce que l'atelier leur profite directement. C'est en amenant des spécialistes et des praticiens des pays de la région à se rencontrer que l'on pourra identifier les problématiques et questions communes, les prioriser et définir, le cas échéant une approche commune.

Objectifs de l'atelier

L'objectif de l'atelier est double :

- *Identifier les priorités en matière de restauration des écosystèmes dans les petits pays insulaires du Sud Ouest de l'Océan Indien et identifier, parmi ces priorités, des éléments communs permettant une approche régionale.*
- *Etablir les bases d'un réseau régional – informel dans un premier temps.-reliant les institutions, organismes et individus actifs dans le domaine de (i) le contrôle des espèces exotiques envahissantes et (ii) la restauration de sites / écosystèmes d'intérêt Botanique.*

Résultats attendus

1. Identification des principaux problèmes de dégradation des écosystèmes terrestres dans les pays de la région.
2. Amélioration de la connaissance, parmi les intervenants régionaux, sur :
 - Les risques représentés par les espèces exotiques envahissantes
 - Les méthodes de prévention et de contrôle
 - Les expériences régionales en matière de restauration d'écosystèmes d'intérêt floristique.
3. Identification des priorités pour des actions concrètes à caractère régional.
4. Production d'une ébauche de plan d'action régional qui pourra être présenté aux bailleurs pour p.e. être incluse dans le programme environnement actuellement à l'instruction (9ième FED) ou au GEF, FFEM

Lieu et date

L'atelier se tiendra aux Seychelles sous le patronage du Département des Forêts et de la Conservation, du lundi 13 au vendredi 17 octobre inclus.

L'atelier sera de type résidentiel et se tiendra au Berjaya Mahé Beach Hotel.

Des visites de sites seront organisées dans les Hauts de Mahé, au Jardin botanique et sur une île où sont mis en place des programmes de gestion / conservation (Cousin).

Regional Workshop on Invasive Alien Species and Terrestrial Ecosystem Rehabilitation for Western Indian Ocean Island states – Sharing Experience, Identifying Priorities and Defining Joint Action

Seychelles - Monday 13th to Friday 17th October 2003

Introduction

The IOC Regional Environment Programme identified the conservation and safeguarding of endangered endemic plant species and their habitats and Integrated Coastal Zone Management as its two main objectives. The former objective was progressively neglected with activities being concentrated on the latter. In spite of this conservation is of great interest to Indian Ocean countries all of which have a flora and fauna characterized by a high level of endemism.

The Seychelles approached the IOC with a proposition for action and future projects in the field of plant conservation and the restoration of degraded areas.

The Regional Environment Programme is reaching the end of its financing period and will be closed in December. From this time it will no longer be possible to begin new activities in project areas. Given this situation it seemed opportune to organise a regional workshop that brought together practitioners from the field together with international specialists from the World Conservation Union (IUCN) to look at regional experiences in restoration of degraded areas with a specific focus on Invasive Alien Species (IAS).

The IOC is establishing, under European financing, a regional project to protect land under cultivation ('Projet PRPV), which will be looking at questions of importation of plant material and quarantine. The theme of invasive alien species is, therefore, among the concerns of the IOC in terms of sustainable development of natural resources.

Context

The IOC countries have diverse ecosystem management problems, with a perceived two way split between Seychelles/Mauritius/Réunion and Comoros/Madagascar where invasive species in modified ecosystems and deforestation are respective priorities

Annex 1: Seychelles IAS Workshop Schedule

(although many individuals within the latter group do believe invasive alien species to be a major problem).

However, it is proposed to focus the workshop mainly on Mascarenes and Comoros as the sheer size of Madagascar, the nature of IAS and the priorities are quite different from the small islands.

With the diverse nature of the terrestrial ecosystem problems it is important that any regional work undertaken focuses on overlapping areas e.g. restoration of ecosystems and mechanisms for sustainable management and has clear benefits to all island states. Common ground needs to be established by a process that brings together key stakeholders from the member states and regions for a focussed but far ranging discussion. This can be achieved by the proposed participatory workshop detailed in this document.

Workshop Goals

The goals of the workshop are:

- *To identify priorities for terrestrial ecosystem restoration within the small island states of the south-western Indian Ocean and elements within these priorities that can be implemented at a regional level.*
- *To establish the basis of a regional IAS network linking resource persons, institutions and conservation bodies within the IOC region that are active in the areas of: (i) management of invasive alien species and (ii) the restoration of ecosystems of biodiversity importance.*

Expected results

1. Identification of regional terrestrial ecosystem degradation problems.
2. Improvement of collective understanding among the regional participants of:
 - Risks represented by invasive alien species
 - Methods of management of invasive alien species
 - Regional experiences in the area of restoration of sites of high biodiversity value.
3. Identification of priorities at regional level
4. Drafting of a preliminary outline / identification paper of a regional plan of action that could be presented to donors for possible inclusion in the environment programmes currently being formulated under the 9th EDF or GEF, FFEM, etc.

Location and date

The workshop will be held in Seychelles and hosted by the Forest & Conservation Dept. (Min. of Environment) from Monday 13th to Friday 17th October inclusive.

The workshop will be residential and will take place at the Berjaya Mahé Beach Hotel. Field visits will be organised in Mahé (upland site), to the botanic garden on Mahé where innovative ex-situ conservation work is being undertaken and to Cousin Island where a conservation management programme is being implemented.

Workshop Activities

Day 1 Monday 13 Oct 03 Lundi 3 octobre

Setting the scene: A review of regional terrestrial ecosystem degradation problems and restoration priorities / état des lieux au niveau régional – la problématique de la dégradation des écosystèmes terrestres - les priorités en matière de restauration.

1. Ouverture officielle de l'atelier :

- allocution de M. Michel Vielle, Directeur des Services Forestiers
- allocution de M. Didier Slachmuylders, Commission de l'Océan Indien
- ouverture officielle par Monsieur le Ministre de l'Environnement

2. An introduction to the workshop and the issue of invasive alien species.

The work of IUCN SSC groups and in particular to the Indian Ocean Plant Specialist Group. / Introduction à l'atelier et à la problématique des espèces exotiques envahissantes. Présentation de IUCN SSC groups et en particulier du Indian Ocean Plant Specialist Group.

Par / by :

Dr. John Mauremootoo (IOPSG). The work of IUCN in invasive species management –
Dr. Souad Boudjelas of the IUCN Invasive Species Specialist Group's Island's initiative.

3. Synthesis of the FAO survey on woody invasive species in the Mascarenes and the Comoros Islands

Présentation d'une synthèse de l'enquête FAO sur les espèces ligneuses envahissantes

Par / by :

Christophe Kueffer (ETH Zurich) & Pierre Vos (Dept. Env. Seychelles, ex- FAO).

4. Country/island presentations / Présentation des rapports nationaux La Réunion :

1 - Status of methods for weed control undertaken by the National Forest Service in La Réunion -

Mr. Alain Brondeau (Office National des Forêts de La Réunion).

2 - Synthesis of research and legislation on invasive alien plants in La Réunion

Dr. Thomas Le bourgeois (CIRAD-CA Réunion).

3 - Support for research in restoration ecology: the example of the research project « Invasions Biologiques INVABIO » in La Réunion

Dr. Christophe Lavergne (Conservatoire Botanique National de Mascarin).

4 - Ecological restoration in La Réunion

Mr. Julien Triolo ((Office National des Forêts de La Réunion).

Annex 1: Seychelles IAS Workshop Schedule

Mauritius :

5 An overview of invasive species issues and management of invasive species for biodiversity conservation in Mauritius

Mr. Sooraj Gopal (National Parks and Conservation Service)

6 An overview of invasive species issues and management of invasive species for biodiversity conservation in Rodrigues

Mr. Richard Payendee (Mauritian Wildlife Foundation)

7 – Research work undertaken at the University of Mauritius of relevance to the management of invasive species for the restoration of biodiversity

Mr. Vincent Florens (University of Mauritius)

8 – Work undertaken by the Mauritian Wildlife Foundation for the management of invasive species for the conservation of biodiversity

Dr. John Mauremootoo (Mauritian Wildlife Foundation).

Seychelles :

9 - IAS and Conservation in Seychelles

Michel Vielle, Director of Forestry Dept. , Ministry of Environment , Seychelles

Day 2. Tuesday 14 Oct. 03 Mardi 14 octobre 03

Visit to upland site in Mahé / visite d'un site dans les Hauts : Mare aux Cochons

Continuation of Monday's country presentations :

IFR Comoros

10.- La forêt du Khartala, enjeu de conservation

Yahaya Ibrahim, CNDRS, Comores

11.- Situation de la forêt à Anjouan

Hailane Ali Abdou, chef du dept. Environnement et Forêt – Ile Autonome d'Anjouan

National, Regional and International Approaches to Invasive Species Management

The relevance of these approaches to the situation in the islands of the south-western Indian Ocean.

Les approches nationales, régionales et internationales de la gestion des espèces envahissantes, leur pertinence par rapport à la région Sud Ouest Océan Indien

- The Global Invasive Species Programme
- The South African Working for Water Programme
- The IUCN Invasive Species Specialist Group Island's Initiative
- The South Pacific Regional Environment Programme initiative on Invasive Species

Presentation on Island Conservation Society by Gerard Rocamora

Day 3 Wednesday 15 October 03 Mercredi 15 octobre 03

Site visit – Cousin Island, a site successfully restored through management of IAS.

Visite de l'île Cousin (site réhabilité et géré par Nature Seychelles).

Day 4. Thursday 16 October 03 Jeudi 16 Octobre 03

Perceived terrestrial ecosystem degradation problems and restoration priorities within the IOC region.

Activities

Plenary session on national and regional priorities for IAS management

Group discussion on themes elaborated during the morning's plenary followed by a plenary session to discuss points raised and the possibility of adopting a regional approach for dealing with some of the priority areas identified.

Day 5 Vendredi 17 octobre 03 Friday 17 October 03

Groupe : Visit to “Centre de Biodiversité de Barbarons”

Some very interesting trials are being carried out in this site on ex situ conservation methods with some of the Seychelles most endangered endemic plant species.

Production of workshop outputs

Group discussion 1 : National and island priorities for IAS management

Group discussion 2. Drafting of workshop outputs

Group 1 : Draft resolution on IAS for Barbados + 10

Group 2 : Regional action for the plan short to medium term

Group 3 : Logical framework for a future regional project

Discussions on regional exchanges and wrapping up

Discussions between participants on workshop outputs with particular emphasis on exchanges between organisations to help increase regional competence in strategic, operational and administrative areas related to IAS management and ecosystem restoration.

Additional wrapping up activities related to workshop outputs such as concept and discussion documents, workshop proceedings, press release, a conference declaration, etc.

Présentation du CDRom d'identification des adventices dans les cultures (AdvenRun)

Par Thomas Lebourgeois (UMR PVBAMT, CIRAD-Univ. Réunion)

Workshop evaluation

Annex 2: Thematic IAS Management Priorities

Background

In the morning plenary session on Day 4 the workshop participants took part in a brainstorming exercise to identify IAS management priorities at a national and a regional scale. The responses given were categorised under the headings legislation and prevention, awareness raising, information exchange and capacity building. The participants broke up into small groups to discuss each of these major themes. The results of these discussions are summarised in this annex.

Groupe 1: Réglementation Prévention

Participants: Thomas Le Bourgeois (La Réunion), Pierre Vos (Seychelles), Alain Perrine (Mauritius – Rodrigues), Hailane Ali Abdou (IFR Comoros – Anjouan), Lindsay Chong Seng (Seychelles), Jacques Barreau (Seychelles).

Bilan de situation des îles

1 Réviser ou adapter la législation

- Actuellement législation phytosanitaire +/- mise en œuvre
- Pas de législation sur les introductions d'espèces
- Travail en cours à la Réunion (ARI, liste noire et blanche)

2 Absence d'infrastructure aux frontières pour la destruction de matériel interdit

3 Problème de distribution des responsabilités et application des lois

4 Pas de mesure de prévention contre la diffusion inter-île

Propositions

1 Court terme

- Diffusion du protocole ARI aux différentes îles
- Test du protocole sur espèces déjà présentes
- (envahissantes et non envahissantes)
- Analyse comparative des résultats entre îles

2 Moyen terme

- Sensibilisation du public et des professionnels
- Formation des équipes en charge de l'application
- de la réglementation et du control
- Liste régionale (noire et blanche)

3 Long terme

- Amélioration des structures et des équipements
- Soutien aux législateurs pour l'élaboration des décrets

Group 2: Sensibilisation et Awareness

Participants: Christoph. Kueffer (Seychelles), Michel Vielle (Seychelles), Suraj Gopal (Maurice), Philippe Breuil (Réunion), Christophe Lavergne (Réunion), Yahaya Ibrahim (IFR Comoros)

Decliner en actions regionales et nationales

Objectifs/Objectives

Yahaya

Atteindre les acteurs locaux depuis les agriculteurs, acteurs de l'environnement, institution, ONG, Police des frontiere et service phyto
Faire prendre conscience aux comoriens des plantes envahissantes comme le goyavier

P. Breuil

Atteindre les élus
Projets pratique et visuels sans confusions
Matraquer à court terme
Ex : operation Choca par une association pour les élus
Choca

Suraj

Savoir ce qu'on fait
Ex : personnes qui travaillent dans le parc et qui envoi goyavier
Toucher toutes les couches de la société, élus

Christoph

Objectifs spécifique
Groupes spécifique : politicians pb national
Echelle régional
Plus important : Industrie horticole
Processus marketing social
Sensibilisation du public
Prevention sur 2-3 espèces par pays

Michel

Diffusion dans les écoles
Ex Seychelles
Comment diffuser inf dans les autres pays ?
Sensibilisation à l'environnement

Christophe

Toucher les différentes tranches de société à court, moyen et long termes
Harmonisation avec les autres points stratégiques
Restituer le pb des invasions dans le contexte régional
Conflits d'intérêt goyaviers

Journee nationale contre *Clidemia*

Faciliter la transversalite entre les acteurs de la societe

Actions

Décideurs politiques élus responsables institutionnels financiers parlementaires, législateurs,

Moyens et long termes

Persuader avant la préparation des budgets prévoir des actions concretes a financer en amont (libelle large)

Sensibiliser les partenaires bilatéraux (coopération française) et multilatéraux des Comores (Union europeenne, GEF, PNUD).

Sensibilisation des impacts économiques des invasions à quoi ca sert ?

Communiquer utile sur le patrimoine, accueil du public, érosion, emploi

Montrer les retombées locales pour le tourisme vert, baisse de la production agricole

Remarque : coordination avec la réglementation

Court terme

Résultat concret : preparer document concret ratifie officiellement par chaque pays

Ratification (motion) des experts → decideurs

Identifier les arguments par pays, les personnes clefs

Declaration precise suite au workshop 1 page actions simple et concrètes

Réunion : préfecture préfet

Maurice : Parlement

Rodrigues : assemblée

Seychelles Ministre et Parlementaire

Comores : Ministères de l'Environnement de chaque île

Idee l'annee prochaine Ministre de l'environnement de chaque pays Barbados system

Workshop entre decideurs Ministres

Presentation des resultats du workshop papier puis presentation orale

Parler au nom des experts locaux et regionaux et pas au nom de sa structure

Présentation des projets de chaque institution aux decideurs

Long terme

Sensibiliser les personnes en charge du Droit de l'Environnement, Universitaires, Legislatureurs

Appropriation des actions par les decideurs pour leur cote electorale (Ownership)

Meanstreaming

Mise en oeuvre

Budget COI → prévoir 1 page résumé pour les décideurs

Recommandation des experts regionaux (concernant les actions de lutte contre les espèces envahissantes et la restauration des écosystèmes envahis).

Professionnels

Secteur horticole

Pépinieristes
Importateur/ exportateurs
Jardins botaniques publics ou privés
Fleuristes
Paysagistes
Bureaux d'études privés
Privé qui font l'entretien des jardins et service education rural du Ministère (Comores)
Administrateurs de districts Seychelles
Service espace vert – Landscape manager – private and state nurseries
Animalerie
Manifestation autour des fleurs
Associations collectionneurs

Court terme

Outils = liste noire/blanche/grises proposition de categories deja prête (C. Lavergne)
Harmonisation avec la réglementation
Sensibiliser le secteur de l'horticulture par des fiches sur 10 espèces ornementales choisies regionalement cf travail de Sarah BRUNEL Mediterranee
Mise en oeuvre
Chaque pays va constituer une liste nationale noire (les plus envahissantes), liste blanche
Mediatiser chaque fois qu'on découvre une nouvelle espece envahissante (Systeme d'alerte)

Moyen terme

Sensibilisation par la voie réglementaire, adapter la réglementation
Coopération entre chercheurs et compagnies privées
Donner ex avec Jardins Botanique Service Espace Vert et effet boule de neige
Créer des outils qui repondent aux besoins : listes especes rouge/vertes
Actions de sensibilisation pendant les manifestations
Sponsoring des companies pour la vente d'espèces indigènes, projet de restauration

Long terme

Projets pilotes tres visuels : route, parc
Eco-certification, Etiquettes, eco-achat propre pour l'environnement
Encouragements/incitation de l'Etat sur des initiatives privées (incentives)
Promouvoir la vente d'espèces indigènes

Secteur éducatif

Educateurs, rectorat, Ministère de l'éducation
Court terme
Utiliser ce qui existe aux Seychelles pour les autres pays
Moyen et long terme
Support pédagogique, manuel
Arboretum
Projets pilotes Ex de Maurice Atelier
Coordinateur sur le pb des invasions/patrimoine indigène

Secteur agricole

Coopérative
Agriculteurs
Importateurs de graines
Apiculteurs
Court terme
Sensibiliser les syndicates d agriculteurs
Atelier national sur les Invasions Biologiques aux Comores **Urgent COI**

Secteurs touristique

Ecoles hôteliers

Hotellerie

Agences de tourisme
Guide touristique
Tour operator
Court terme
Diffusion d'un reportage dans les avions qui circulent dans l OI

Contrôle et police

Douanes Service de quarantaine
Agents assermentés (Brigade nature, douane, ONF, police des frontières)

Secteur de la conservation

Acteurs de la conservation, ONF, Service Forestier,

Secteur santé traditionnelle

Régler les conflits d'intérêt
Ex Seabean (*Entada rheedii*) aux Seychelles, projet d'introduction du Kudzu à La Réunion, Desirée (*Clidemia*) aux Comores (Mohéli)
Utilisation des plantes envahissantes *Lantana* pour le control sur le terrain
Mise en oeuvre a court terme
Présentation sur les espèces potentiellement envahissante

Grand public

Court terme

Article dans la Presse du workshop

Echanger les articles de presse de chaque pays

Moyen terme

Tous les mois 1 journée sur un theme

Timbres postaux

Recommandations pour les jardiniers : ne pas jeter les déchets verts dans les ravines, bords de route : faire compost au fond du jardin : transport approprié des déchets verts : nettoyer chaussures, sacs, vêtements quand on va en milieu naturel.

Long terme

Seychelle

Presse 1 page tous les Lundi sur les pb environnementaux par les différents services Ministères de l'Environnement

Tous les 2 semaines émission sur l'environnement (agreement)

Régionalement : chaque pays a tour de rôle

Médiatiser des ex d'invasion visuelle dans les îles voisines

Message fort en créole

Group 3: Diffusion/ information exchange

Participants: Vincent Florens (Mauritius), Julien Triolo (Réunion), Colleen Morel (Seychelles), Selby Remy (Seychelles).

Definition of the problem

What do we have in common?

1. Small insular islands
2. Same types of problems and sometimes the same species.

In spite of all this there is very little sharing.

For example a new invasive plant recognised in Réunion. How and to whom is this information communicated to other islands and practitioners in the region?

Actions to be undertaken:

Short term (< 1 year)

1. Propose setting up (Seychelles and Comores) of local committee/ or identify existing groups per country with stakeholders in well balanced composition to discuss and find consensus (Independent group!) (Ex type: Invasive Alien Species Working Group in Mauritius). With working specialised subgroups if need be. Identify these committees if they already exist. Without being too rigid.

Mauritius: Invasive Alien Species Working Group!

Annex 2: Thematic IAS Management Priorities

Rodrigues: Rodrigues Environmental Committee All stakeholders already represented.

Seychelles: To set up working group.

Comores: Multi insular. More difficult to meet. To suggest creation of local group. Can be set up quickly without need to sensitise authorities.

Réunion: Existing `Comite des invasion biologique` to cater for this need. (up to 40 people, NGO, Government etc, once a year).

2. The national group to identify a strategy for diffusion of information locally to see how best to diffuse information. Which may not be by the same means in each country.(Information targeting different levels-community, government etc).

3. Identification of gaps. Themes, research and management needs etc..

4. Draft a proposal of common strategy, which also respects each country`s specificities
Collection and dissemination.

Medium term (1-3 years)

1. Develop a tool for receive and disseminate information (e.g. Newsletter or Internet site used by full time regional coordinator)

2. Facilitate access to all stakeholders and sharing with public (Need in equipment ex: PC, internet, photocopy machines)

3. Ensure that network functions and is sustainable (Quite country specific)

4. Establish network with other regional and international groups?

Long term

1 Constant updating, fine tuning of database (IAS -lists, management measures-, Invaded ecosystems, New findings etc) and validating information by committee.

2. Annual meetings

3. Concrete projects

Inventory of IAS, invaded ecosystems (FAO report)

Prevention of introduction

Control of existing pests

Larger scale work for longer term

Group 4: Capacity Building and Training

Participants: Mike Hill, Katy Beaver, Dennis Matatikan, Alain Brondeau, Frauke Dogley, Richard Payendee and Eva Schumacher

Objectives / Tasks

- Not reinventing the wheel
- Mutual benefits

Annex 2: Thematic IAS Management Priorities

- Keep the momentum generated by this workshop going (short term)

Short term

- **Identification of existing expertise in the region.** List of references/achievements. Permanent/temporary experts.
- Appoint one '**focal point**' per country → **Terms of reference.** Link between national and regional groups (documentation from A to Z, report should be brought to the focal point, newspaper, presentation etc).
- List of the **ongoing research**
- List of **needs of research.** Local/regional stakes. Identify existing links with research institutes (continuity). What can be done regionally? What has to be done with the help of international expertise? Make sure this expertise helps to build capacity.
- Take more advantage of visiting scientists: presentations, feedback
- (National working group in each country)

Short-medium term

- Write a **regional strategy.** Appoint regional coordinator. Checklist of most invasive species within the region(FAO study + herbs, animals,...). Priorities for control.
- National/Regional **exchanges of practices on site** (practitioners, field workers). Bilateral or multilateral level.
- Design a regional **training protocol** (people to be trained, methodology, evaluation, feedback, sharing information, follow up). Draw attention on gender balance
- **Exchanges of students** in the region (financial problems)
- **Exchange of key people for 6 months or more (bourses périodes sabbatiques)**
- **Regional monitoring** of invasive species, early detection
- Coordinator of documentation, **knowledge database**, Information management, Backup system (cf group 3)

Long Term

- Regional **training sessions** and **training center** (for field workers, rangers, scientists etc.) (experience in Mauritius and La Réunion). Use of information technology (Internet/Computer)
- **Regional** toolkit of best practices
- Regional **research programs:** Develop new control methods (mechanical, chemical, biological), habitat rehabilitation/restoration

Fund Raising

- Regional fund raising
- Ecotourism

Annex 3: National and sub-National IAS Management Priorities

Background

Following the identification of general IAS management priorities on Day 4 workshop participants split into national or sub-national island groups to define country or island-specific IAS management priorities. The results of these discussions are summarised in this annex.

Management priorities for La Réunion

Tableau de compétences et faiblesses de la Réunion

Thèmes	Point forts	Points faibles (Priorités)
Formation et renforcement des compétences	- Capacité de former des techniciens, formateurs et universitaires (Université, Cirad, CBNM, ONF, Associations) Sites atelier pérennes Projets pilotes	Pas de coordination Pas de formation au niveau scolaire Pas de sensibilisation du public et des professionnels
Diffusion et échange d'information	Comité Invasions Biologiques Réseau informel Inventaire faune et flore en cours	Pas d'outils de mise à disposition de l'information Pas d'accès depuis l'extérieur Pas de stratégie sur ce point
Sensibilisation et prise de conscience	Quelques petits dépliants et affiches articles de journaux quelques émissions TV Actions ponctuelles peu organisées	Gros problème Pas d'utilisation systématiques des médias Sensibilisation faible des décideurs, professionnels et public
Réglementation / législation	ARI en cours Liste noire et blanche en cours	Manque de moyens humains pour appliquer la législation
Prévention Détection précoce	Début d'observatoire ONF sur le domaine forestier (40% du territoire)	- Extention à l'ensemble du territoire et aux animaux
Prédiction et modélisation des invasions	Projet Univ réunion et RSA en cours	
Recherche	Etudes plantes Etude Bulbul orphée Etudes milieux envahis Programmes Lutte bio en	Pas de stratégie de hiérarchisation des priorités de recherche

Annex 3: National and sub-National IAS Management Priorities

Thèmes	Point forts	Points faibles (Priorités)
	cours sur 2 espèces Etude d'impact de la lutte en milieu naturel	
Gestion des milieux	15 ans d'expérience sur la lutte contre plantes envahissantes Synthèse réalisée 2003 Réseau des gestionnaires Réseau d'acteurs (associations) Programmes de lutte active sur les organismes nuisibles en milieu urbain et agricole (FDGDON) Fourmies, rats, termites, bulbul	Pas de coordination des réseaux et actions Pas de gestion des animaux envahissants en milieu naturel Pas de programme d'évaluation d'efficacité et impact (+ -) des programmes de lutte Manque de collaboration internationale
Ecologie	Milieus de références bien préservés (30%) pour études comparatives inter-îles	
Infrastructures et équipements	Instituts de recherche Instituts de développement Réglementation Financement	Manque de coordination entre structures Manque de visibilité vis à vis de l'extérieur Coût élevés des actions Procédures administratives longues et complexes

Priorités pour la Réunion

- Besoin d'une stratégie globale pour la Réunion
- Hiérarchisation des actions en fonctions des espèces et milieux prioritaires
- Listes d'espèces (différentes catégories d'espèces envahissantes)
- Définition des milieux en fonction de leur sensibilité à l'invasion et de leur valeur patrimoniale
- Analyse de situation, quantification et distribution spatiale des invasions
- Etude et gestion des invasions animales

Mauritius

Management priorities for Mauritius

Much work at various levels is currently ongoing on Mauritius concerning IAS management as seen in this document. By and large these activities need to continue. However, it was felt that the following areas deserved the greatest immediate future attention:

1. The extension of existing Conservation Management Areas (CMAs), given that large-scale control of alien species as done in these CMAs is a must for native populations to be viable in the long term. This may not necessarily involve greater resource input. Rather it may come through more judicious allocation of resources and increased cost effectiveness of IAS control. Research has an important role to play here.
2. The selection and IAS-management of further biodiversity rich areas currently threatened by IAS and not receiving adequate management. This includes the extension of the Black River National Park to include areas such as Bassin Blanc; the creation of the Islets National Park; and the setting up of further CMAs in areas of high conservation value. These new areas will have to be managed against IAS.
3. Management must imperatively shift from the low cost effectiveness of a species by species conservation strategy to a high cost effectiveness ecosystem oriented management.
4. Ecological restoration of habitats to be encouraged in view of increasing their resistance to IAS-driven degradation.
5. Mainstreaming of the struggle against IAS is a must to win increasing support and success.
6. Elaboration of a national IAS strategy by a multi-stakeholder forum and the securing of sufficient resources for its implementation. Among the elements of such a strategy are the following:
 - a. A review of the legal framework and policies to prevent the entry of IAS into the country.
 - b. Training of key personnel e.g. park wardens, customs officers, etc. in IAS control strategies and techniques.
 - c. Development of a biodiversity emergency response plan for major threats to biodiversity. e.g. there is no contingency plan for introduction of rats or other pests onto the islets off the northern coast of Mauritius.

Management priorities for Rodrigues

1. Need to survey IAS present on the island. Use results to set up black list using existing expertise in the region.
2. Use of existing education programme on the environment to introduce the concept of IAS to raise awareness on the issue at different levels.
3. Extend phytosanitary measures to include IAS – Apply quarantine measures to IAS.
4. Review of existing legislation as a preventive and corrective measure for the introduction of IAS
5. Continue and upscale on-going conservation work. Identify and prioritise key conservation sites.

Management priorities for Seychelles

1. Prevention - Legislation

Short term

- Harmonise western region, black/white list

Medium term

- Infrastructure/enforcement/disposal mechanisms

2. Early Detection

Short/medium (ongoing)

- Toolkit: adapt and implement
- Early detection and rapid response mechanism
- Capacity building – training for customs / officials
- Cooperation – How to? NGO / Government and islands ? flora & fauna
- Awareness
- Promote other species (e.g. natives and not invasive exotics) as ornamentals and inform horticulturalists (white and blacklist approach)
- How to dispose excess plant material?

3. Control/Eradication

Short term

- Prioritise sites / importance
- Containment activities (adapt from other countries) for specific species

4. Control/Restoration

1. Prioritise habitats / small islands

Management priorities for IFR Comoros

Six niveaux de conservations se distinguent

1. La tenue le plus tôt possible d'un atelier national sur les espèces exotiques envahissantes (EEE) afin de définir une stratégie nationale sur les EEE.
2. Adhésion au réseaux d'information formels ou informels existant afin d'échanger de l'information sur la prévention et la gestion des EEE.
3. Restauration et gestion de forêts de moyenne altitude par:
 1. Lutte contre les EEE
 2. Gestion durable des ressources pour la mise en place d'une dynamique socio-economique
4. Conservation intégrale de la forêt de haute altitude et
5. Réglementation et gestion des EEE par la mise en place:
 3. d'un cadre réglementaire appropriée pour la lutte et la prévention des EEE
 4. d'une structure de gestions qui impliquent tous les opérateurs locaux.

Management priorities for Anjouan

1. Restauration des espèces endémiques, indigènes sur le Mont Ntringui pour conservation des espèces on voie de disparition.
2. Développer des méthodes biologiques et génétiques de lutte contre les espèces envahissantes
3. Protection du Mont Ntringui. Protection intégrale du lac Dzialadze en laissant régénérer ou en restaurant des espèces adaptées dans la région.
4. Restauration des sites menacés.
5. Réglementation homogène sur la circulation des échanges – renouvellement de la loi cadre.
6. Un coordinateur national au niveau de l'union et 3 coordinateurs locales au niveau de chaque île – Anjouan, Mohéli et Grande Comore.
7. Reconnaissances des espèces indigènes et recherches sur ces espèces animaux et végétales.

Annex 4: How to best Maintain the Enthusiasm and Momentum established at the Workshop

At the Day 4 evening plenary session all the participants agreed that a positive way forward for the management of IAS in the small islands of the western Indian Ocean was to establish a project for a regional network to exchange information and skills. There was a general consensus that the enthusiasm and momentum generated by this workshop must be captured and build upon. In this regard there was concern that before a funded project is developed that the momentum and interest in the issue catalysed by the workshop will be lost.

There was concern about the best way to maintain this momentum in the short term. The following suggestions were put forward:

- The establishment of an interim and informal information exchange on IAS-related matters in the region through the IUCN Indian Ocean Plant Specialist Group
- The establishment of national focal points to coordinate the IAS network.
- The establishment of an interim and informal information exchange on IAS-related matters in the region through the IUCN Indian Ocean Plant Specialist Group with the help of national focal points.
- The establishment of a new network to exchange information on IAS-related matters in the region.

Following the plenary session discussions were held about these suggestions. It was felt that it would be best that the momentum from the workshop should be kept *informally* at this stage.

A project outline will be developed at the workshop. Each delegation will discuss with their respective national authorities for validation (i.e. assessment of the relevance of a proposal for an eventual submission to a funding agency through the IOC). If the countries validate the project outline it will be tabled at the Conseil des Ministres at the beginning of February 2004.

We suggest that such a project could fall within the framework of GEF. The reason being that GEF is already funding other IAS projects such The Global Invasive Species Programme.

In the meantime the maintenance of the momentum from this workshop depends on the goodwill and commitment of the participants of this workshop. Some of this could be maintained through the adoption of immediate follow-up activities, some of which are summarised in Annexe 5.

Annex 5: Proposals for Action on IAS in the Short, Medium and Long Terms

Background

As outlined in Annex 4 it was clear that workshop participants were keen to maintain the enthusiasm and momentum generated during the current workshop. A GEF-type project to establish a regional IAS network is a desirable goal. However, it is clear that such a project will take some time to implement. Therefore, it was felt that it was important to elaborate regional actions that could be taken more immediately. One of the groups in the Day 5 group sessions (Annex 1), therefore, was assigned to the task of identifying actions that could be taken on IAS at the regional level in the short as well as the medium and long terms. The results of these deliberations are summarised below

A. Proposition d'actions à courte terme : immédiat

Un réseau d'échange d'information au niveau régional

Le plus simple et le moins coûteux : liste e-mail

Condition de participation

- disposer d'une adresse e-mail
- adhésion individuelle

Animateur / modérateur :

- Proposition 1 : IUCN IO PSG
- Proposition 2 : un réseau indépendant ??? Qui ???

Un forum de discussion (p.e. Yahoo groups)

Faut-il un forum spécifique « Sud Ouest OI » ou le forum « Alien-L » est-il suffisant ?

Qui va être le modérateur si un forum spécifique est créé ?

Coût : **NIL, base bénévole, utilisation d'outils existants.**

B. Proposition d'actions à moyen terme

PRPV

Dans le cadre du PRPV, des bases de données sur les ennemis des cultures vont être mises en place dans chaque pays membres mais pourront être consultées via un site WEB global, accessible à tous. Les bases de données incluront des informations sur les adventices (mauvaises herbes).

Chaque pays sera responsable de sa propre base de données. Les informations techniques et scientifiques seront mises en ligne après validation par un comité scientifique.

Un service questions-réponses sera développé.

Définition, recommandations / préconisation de « bonnes pratiques » en matière de lutte contre les ennemis des cultures (y compris méthodes alternatives).

Annex 5: Proposals for Action on IAS

Qui ?

- La coordination régionale du projet PRPV
- Les points focaux nationaux :
 - Comores : INRAPE
 - Madagascar : service de protection des végétaux et FOFIFA
 - Maurice : service de protection des végétaux – Min. Agriculture
 - Seychelles : service de protection des végétaux – Min. Agric.
 - Réunion : service de protection des végétaux, pôle 3P

Lien avec IAS : Thomas Lebourgeois, CIRAD et UMR PVBMT CIRAD / Univ. Réunion

Recommandations :

1. Le compte-rendu de cet atelier et ses recommandations seront présentés lors du premier comité scientifique de pilotage du PRPV (mi-novembre, Maurice).

Qui ? Didier – COI

1. Etudier la possibilité d'adapter ces outils (système GBD et site Web / système de consultation) à la problématique des invasions biologiques et de la restauration des milieux.

Qui ? Thomas Lebourgeois, CIRAD et UMR PVBMT CIRAD / Univ. Réunion
Financement ?

PRPV : projet régional financé sur le 8^{ième} FED, en cours

Adaptation de l'outil ? **financement à trouver (Région Réunion ?)**

Dynamisation d'ONG environnementales aux Comores

Rôle des ONG comoriennes en matière de conservation?

- S'inspirer des actions ONG coelacanth, Roussette de Livingstone
- Identifier quelques priorités et lancer des actions de base avec sensibilisation des populations (appui scientifique du CNDRS)
- Utiliser les contacts personnels internationaux pour essayer de trouver / motiver un éventuel partenaire international (ONG internationale)

Rôle / contribution des ONG internationales ?

- Effectuer très rapidement un « rapid appraisal » pour identifier des sites / habitats prioritaires (essences endémiques, faune surtout oiseaux).

Actions bilatérales

La délégation réunionnaise propose des échanges bilatéraux entre les services à la Réunion (ex.. ONF) et les services concernés dans les pays.

Prise en charge financière : la Réunion

Appui du GSIP

IUCN Indian Ocean Plant specialist Group va approcher le GSIP pour étudier les possibilités d'un appui ponctuel éventuel puisque le programme du GSIP mentionne : « We also propose regional activities to develop national capacity and regional cooperation in the prevention and management of IAS : This programme proposes to help governments and development agencies to identify and initiate national and regional projects to mitigate threats posed by IAS »
(source : A Global Strategy on Invasive Alien Species IUCN in collaboration with GSIP)

Qui ? IUCN IO PSG – John Mauremootoo.

3. Proposition d'actions à long terme :

Démarche à suivre pour qu'un projet puisse être porté par la COI :

- les délégations nationales ayant participé à l'atelier font valider la proposition par leur service de tutelle (ex. Min. Environnement) et/ou le comité national IAS.
- la demande de projet est soumise à la COI via les OPL par au moins 2 pays
- Validation lors du conseil des Ministres (Comores, février 04)
- Soumission par la COI à un bailleur (FED, GEF, FFEM)

Qui ?

Les pays membres
La COI

Calendrier ?

Rapport d'atelier sera transmis aux pays et aux participants à partir de

N.B. : format CDRom + documents (présentations des pays) seront disponibles en .pdf téléchargeables au départ du site de la COI.

Si la demande est validée par les autorités, soumission à un bailleur (GEF / World Bank ?) au début 2004.

N.B. : nous proposons que la COI approche le GEF / World Bank

Cette problématique cadre avec les domaines d'intervention de ce bailleur

Le GEF appui le GISP

La COI a un bon « track record » avec ce bailleur (projets ROSCPP et Regional Reef Monitoring Network).

Dans ce cas, la première étape serait de demander unPDF-A – Project Development Fund (max. 25,000 \$).

Annex 6: Logframe for a Regional IAS Management Project for the Small Islands of the South West Indian Ocean

Objectif global

Maintenir la biodiversité dans les îles du SO OI

Objectif spécifique

Prévenir et contenir les invasions biologiques dans les îles du SO OI

Résultats attendus

- R1. l'introduction de nouvelles espèces envahissantes est évitée
- R2. l'installation de nouvelles espèces envahissantes est évitée
- R3. les espèces envahissantes avérées sont contenues et/ou éradiquées
- R4. la résistance des milieux terrestres aux invasions biologiques est renforcée
- R.5 un réseau régional de compétences est mis en place et sa pérennisation est assurée

Activités

Activés menant à R1.

- A.1.1. appuyer l'élaboration et l'harmonisation au niveau régional de réglementations
- A.1.2. développer et mettre en œuvre des protocoles d'analyse de risque
- A.1.3. des listes d'espèces envahissantes sont établies à l'échelle nationale et régionale

Activités menant à R2.

- A.2.1. Mettre en place et animer un réseau de veille et d'alerte régional
- A.2.2. Mettre en place un système d'évaluation et d'analyse de risques
- A.2.3. Mettre en place et rendre opérationnel un système d'intervention rapide
- A.2.4. Evaluer l'efficacité du système et améliorations éventuelles

Activités menant à R3

- A.3.1. mettre au point les outils et protocoles de caractérisation et quantification des invasions et de leur impact
- A.3.2. inventorier les méthodes de lutte existantes, les adapter éventuellement, mettre au point de nouvelles méthodes
- A.3.2. réaliser et actualiser un guide de bonnes pratiques
- A.3.3. mettre au point des outils d'évaluation

Activités menant à R4

- A.4.1. mettre au point une méthodologie pour définir les états de référence
- A.4.2. mettre en place un réseau de sites ateliers à l'échelle régionale
- A.4.3. inventorier les méthodes de restauration existantes, les adapter éventuellement, mettre au point de nouvelles méthodes
- A.4.4. réaliser et actualiser un guide de bonnes pratiques
- A.4.5. mettre au point des outils d'évaluation

Annex 6: Logframe for Possible Regional IAS Management Project

Activités menant à R5

- A.5.1. Identifier les compétences au niveau régional (au niveau institutionnel, ONG et individus)
- A.5.2. Structurer et pérenniser le réseau
- A.5.3. Identifier les connaissances, sources documentaires
- A.5.4. Structurer et alimenter des bases de connaissance (espèces, milieux,...)
- A.5.5. Formuler une stratégie régionale.

Actions transversales

- A.6.1. Identification les différents acteurs
- A.6.2. Assurer la communication à tous les niveaux / réaliser des campagnes de sensibilisation adaptées en fonction des publics-cibles (scolaire, professionnels, touristes et services, décideurs, administrations etc.)
- A.6.3. Identifier les besoins en formation
- A.6.4. Mettre en place et/ou donner accès à des formation technique (échange de pratiques, formations courtes)
- A.6.5. Mettre en place et/ou donner accès à des formations diplômantes et bourses de recherche

Annex 7: Proposed Declaration to the Barbados + 10 Meeting

Background

Mauritius will be hosting the Barbados + 10 International Meeting on Small Island Developing States in August 2004. This high profile meeting will present a very good opportunity to get IAS issues towards the top of the agenda for Small Island Developing States. With this in mind, Ronny Jumeau the Seychelles Minister of Environment urged this workshop to come up with a resolution to be tabled at the meeting. The participants at the workshop agreed on the following draft resolution:

Draft ‘Seychelles’ resolution on IAS

Considering that the southwest Indian Ocean islands have been identified as a biodiversity hotspot during the global biodiversity assessment undertaken under the CBD and that invasive alien species have been identified as the second most important threat to biodiversity globally (CBD article 8h).

We, the member states of the Indian Ocean Commission, reaffirm that islands are particularly vulnerable to the effects of invasive alien species and that in the south-west Indian Ocean Islands invasive alien species have become a major agent of environmental and landscape change with immense and increasingly detrimental effects.

We reaffirm that apart from ecological impacts invasive alien species also have serious economic, social and health implications.

Therefore, we commit ourselves to increase our efforts to minimize the impact of invasive alien species at community, national and regional levels by prevention, containment and mitigation measures.

We recognise the need to expand and strengthen habitat restoration programmes in key conservation areas.

We call upon all SIDS and other islands to join and reinforce cooperative efforts.

Annex 8: Some Resources of Relevance to IAS Management

This list of sources of IAS information has been compiled by the IUCN Invasive Species Specialist Group (ISSG).

General websites

ISSG Global Invasive Species Database

URL: <http://www.issg.org/database/>

The ISSG Global Invasive Species Database gathers and disseminates the knowledge and experience of invasive species experts from around the world. It provides access to essential information on all types of invasive alien species with a major focus on those that threaten biodiversity. The database provides users with basic facts in plain language, as well as the means to seek further information via links to other information sources, or to experts who can offer specific advice.

Contact: Michael Browne: m.browne@auckland.ac.nz

Keywords: global, invasive species, management information, contact people, prediction.

Global Invasive Species Programme (GISP)

URL: <http://www.gisp.org>

The site for the Global Invasive Species Programme. Offers information on pathways of invasives and risk assessment, early warning systems, legal and institutional frameworks, assessment and best management, economic consequences, and current status and assessment of invasives.

Contact: Ms Kobie Brandt: Brandt@nbict.nbi.ac.za

Keywords: pathways, risk assessment, early warning systems, legislation.

MABFlora & MABFauna Online

URL: <http://ice.ucdavis.edu/mab/>

The Information Center for the Environment, in association with the U.S. Man and the Biosphere (U.S. MAB) Program, is developing databases of vascular plant and vertebrate animal occurrences on the world's biosphere reserves and other protected areas. Currently, the MABFlora (for vascular plants) and MABFauna (for vertebrate animals) databases contain records from over 740 protected areas in 103 countries.

Contact: info@ice.ucdavis.edu

Keywords: vascular plant, vertebrate animal, reserves, protected areas, global.

National Biological Information Infrastructure - Invasive Species Databases

URL: <http://www.invasivespecies.gov/databases/main.shtml>

A collection of invasive species resources available on the Internet.

Contact: invasive@nal.usda.gov

Keywords: global, databases

PAPERS, REPORTS AND BIBLIOGRAPHIES

Bioinvasions: Stemming the Tide of Exotic Species

URL: <http://www.wri.org/wri/wri/wr-98-99/bioinva2.htm>

An article by the World Resources Institute highlighting the threat posed to biodiversity by non-native species and efforts made to stem the tide of bioinvasions.

Contact: gregm@wri.org

Keywords: bioinvasions

Exotic Introductions

URL: <http://darwin.bio.uci.edu/~sustain/bio65/lec09/b65lec09.htm>

A chapter on exotic species from a hypertext book by Peter J. Bryant titled Biodiversity and Conservation.

Contact: Peter J. Bryant: pjbryant@uci.edu

Annex 8: Some Resources of Relevance to IAS Management

International Programs News, Office of International Programs, USDA Forest Service

URL: <http://www.fs.fed.us/global/news/>

A series of articles on invasive exotic species.

Contact: Robin Maille: r.maille@if.arctic.com

Keywords: exotic species

Invasive Species: Control and Management Technologies

URL: <http://www.nal.usda.gov/ttic/misc/picontrl.htm>

A bibliography on the control and management of invasive species, abstracts are included where available.

Compiled by Mary Stevanus (Technology Transfer Information Center) from AGRICOLA database.

Contact: ttic@nal.usda.gov

Keywords: control, management, invasive species, global

Space invaders: modelling the distribution, impacts and control of alien organisms

URL: http://cas.bellarmine.edu/tietjen/Ecology/space_invaders.htm

Review of some modelling work on invasive species.

Contact:

Keywords: modelling, distribution, impacts, control

Regional websites

Agricultural Research Service

URL: <http://www.ars.usda.gov/index.html>

The Agricultural Research Service (ARS) is the principal research agency of the U.S. Department of Agriculture (USDA). ARS, one of the Research, Education and Economics (REE) agencies, is charged with extending the Nation's scientific knowledge across a broad range of program areas that affect the American people on a daily basis.

Contact: arswbmaster@ars.usda.gov

Keywords: biological control, invasive species

Baltic Sea Alien Species Database

URL: <http://www.ku.lt/nemo/mainnemo.htm>

Inventory of alien species in the Baltic Sea along with references related to each listed species. Hosted by the Coastal Research and Planning Institute, Klaipeda University, Lithuania the database deals with marine invertebrates, algae, plants, and fishes in the Baltic Sea region.

Contact: Sergej Olenin: s.olenin@corpi.ku.lt

Keywords: Baltic Sea, marine species, biology, vectors of introduction, spread, impacts on the environment and economy

Directory of Non-native Marine Species in British Waters

URL: <http://www.jncc.gov.uk/marine/dns/>

A database of non-native marine species in British waters hosted by the Joint Nature Conservation Committee (JNCC), United Kingdom. The website contains information on marine invertebrates, algae, and plants in the United Kingdom. Information provided for each listed species includes: date and method of introduction, origin, reasons for success, rate of spread and methods involved, distribution, factors likely to influence spread and distribution, effects on the environment, effects on commercial interests, control methods used and effectiveness, beneficial effects, and references.

Contact: Clare Eno: eno_c@jncc.gov.uk

Keywords: taxonomy, introduction, distribution, impacts, management, non-native marine species, Great Britain

Annex 8: Some Resources of Relevance to IAS Management

Great Lakes Information Network

URL: <http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html>

Since the 1800s, more than 140 exotic aquatic organisms of all types - including plants, fish, algae and mollusks - have become established in the Great Lakes. More than one-third of the organisms have been introduced in the past 30 years, a surge coinciding with the opening of the St. Lawrence Seaway. The Great Lakes Information Network (GLIN) is a partnership that provides one place online for people to find information relating to the binational Great Lakes-St. Lawrence region of North America.

Contact: jcolman@glc.org

Keywords: Crustaceans, Fish, Mollusks, Plants

Hawaiian Ecosystems at Risk Project (HEAR)

URL: <http://www.hear.org/>

Extensive source of information on invasive species in Hawaii, the purpose of which is to provide resources to natural resource managers in Hawaii to aid fight alien species statewide. Available resources include: websites, online text of scientific and/or news articles regarding harmful alien species in Hawaii, weed lists, databases including, the Harmful Nonindigenous Species in Hawaii (HNIS) database which is an online source of information about harmful non-native species in Hawaii, and includes links to alien species sites, and relevant information. HEAR hosts the website for the Pacific Island Ecosystems at Risk (PIER) project.

Contact: Philip A. Thomas: pt@hear.org

Keywords: Hawaii, management, control

Invasive Species

URL: <http://www.environment.gov.au/bg/invasive/>

Information on various pest animals, weeds, non-native insects and other invertebrates, introduced marine pests, and diseases and parasites in Australia. Also provides links to online texts of the Endangered Species Act 1992 and the Environmental Protection and Biodiversity Conservation Act 1999.

Contact:

Keywords: Australia, pest animals, weeds, marine pests, non-native insects, diseases, parasites

National Marine and Estuarine Invasions Database (NIS)

URL: <http://invasions.si.edu/nis.htm>

The Smithsonian Environmental Research Center (SERC) database focuses on marine and estuarine alien species in U.S. waters, including organisms that occur in tidal waters of all salinities (i.e., freshwater to full marine salinities). The primary goal of this database is to describe the patterns and effects of alien species invasions in coastal communities on multiple spatial and temporal scales. Includes the Chesapeake Bay Nonindigenous Species List.

Contact: murphy@serc.si.edu

Keywords: taxonomy, invasion history, population biology, community ecology, economic impacts, references

NatureServe

URL: <http://www.natureserve.org/>

A source for authoritative conservation information on more than 50,000 plants, animals, and ecological communities of the United States and Canada. NatureServe provides in-depth information on rare and endangered species, but includes common plants and animals too. NatureServe is a product of the Association for Biodiversity Information in collaboration with the Natural Heritage Network. Biological and Conservation Data. It provides key biological and conservation data for more than 50,000 species of plants, animals, and ecological communities in the U.S. and Canada, including Heritage status ranks, U.S. federal status, Canadian COSEWIC status, United States and Canadian state/province distributions, general species descriptions, habitat and management requirements, taxonomy, and literature sources.

Contact: natureserve@abi.org

Keywords: plants animals, ecological communities, U.S.A., Canada

Annex 8: Some Resources of Relevance to IAS Management

Nonindigenous Aquatic and Selected Terrestrial Species of Florida

URL: <http://aquat1.ifas.ufl.edu/mctitle.html>

Online report by James A. McCann, Lori N. Arkin, and James D. Williams published by the University of Florida, Center for Aquatic Plants, on the introduction of non-indigenous aquatic species into Florida.

Hosted by the National Biological Service, Southeastern Biological Science Center, the website contains 1996 information on the status, pathways and times of introduction, and the economic and environmental effects on the native flora and fauna of freshwater, marine, terrestrial nonindigenous species.

Contact: varamey@nervm.nerdc.ufl.edu

Keywords: Florida, freshwater, marine, terrestrial, plants, animals

SAFRINET

URL: <http://safrinet.ecoport.org/>

SAFRINET is the SADC (Southern African Development Community) network of BioNET-INTERNATIONAL. SAFRINET, as a taxonomic capacity building network, is concerned with living organisms, the identification of the pollinators, species that enhance soil fertility, biocontrol organisms, pests and diseases to name a few of the more important groups..

Contact: vrehcde@plant5.agric.za

Keywords: Southern Africa

United States Department of Agriculture-Animal and Plant Health Inspection Service - Information Management System for Invasive Species

URL: <http://www.invasivespecies.org/>

Hosts three searchable databases of: (1) plant pests; (2) invasive plants and (3) North American non-indigenous arthropods.

Contact: Kenneth R. Lakin: Kenneth.R.Lakin@usda.gov

Keywords: non-indigenous arthropods, pest plants, North America

U.S. Fish and Wildlife Service Invasive Species Program

URL: <http://invasives.fws.gov/>

Focuses on issues dealing with the prevention and control of invasive plant and animal species in the United States. On-line copy of the presidential executive order on invasive species is available on this site.

Contact: Mike Ielmini: michael_ielmini@fws.gov

Keywords: prevention, control, invasive plants, invasive animals, Legislation, United States

PAPERS, REPORTS AND BIBLIOGRAPHIES

Francisco Bay/Sacramento-San Joaquin Delta Estuary

URL: http://elib.cs.berkeley.edu/cgi-bin/doc_home?elib_id=821

A scanned version of a briefing paper produced by the Bay-Delta Oversight Council. This document can be viewed and searched online.

Contact: www@elib.cs.berkeley.edu

Department of Land and Natural Resources, State of Hawaii - Alien Species

URL: http://www.hawaii.gov/dlnr/Alien_Species.html

Webpages highlighting the impact alien species are having on Hawaii's flora and fauna. Also includes recommendations to the public about how to help protect Hawaii from alien pests.

Contact: dlnr@pixi.com

Keywords: Hawaii

Exotic Species in Louisiana

URL: <http://www.tulane.edu/~bflcury/envirobio/enviroweb/ExoticSpecies.htm>

Information on nutria, red fire ant, monk parakeet, water hyacinth, Chinese tallow, Eurasian collared-Dove, and cattle egret in Louisiana.

Keywords: nutria, red fire ant, monk parakeet, water hyacinth, Chinese tallow, Eurasian collared-dove, cattle egret, Louisiana

Annex 8: Some Resources of Relevance to IAS Management

Harmful Non-indigenous Species in the United States

URL: http://www.wws.princeton.edu/~ota/disk1/1993/9325_n.html

Report by the Office of Technology and Assessment. It covers issues such as causes and rates of introductions, impact of harmful non-indigenous species, application of decision making methods, international law and global changes. Non-indigenous species in Hawaii and Florida are presented as case studies in Chapter 8. Downloading option is available.

Keywords: United States, Hawaii, Florida, legislation

Harmful Non-Native Species: Issues for Congress III April 8, 1999

URL: <http://www.ncseonline.org/NLE/CRSreports/Biodiversity/biodv-26b.cfm>

Online transcript of a document produced by the Congressional Research Service dealing with issues such as: pathways of invasion, basic methods of pest prevention and control, and economic and environmental effects. Site maintained by The Committee for the National Institute for the Environment.

Contact: cnie@cnie.org

Keywords: non-native species, prevention and control

Impacts of Introduced Species in the United States

URL: <http://www.gcario.org/CONSEQUENCES/vol2no2/article2.html>

An article on the impacts of introduced species in the United States, published by Daniel Simberloff in Consequences Volume 2, Number 2.

Contact: Daniel Simberloff:

Keywords: introduced species, United States

Nonindigenous Species

URL: <http://biology.usgs.gov/s+t/SNT/noframe/ns112.htm>

A chapter on non-indigenous species in Part 1 of an online report by the U.S. Geological Survey: "The Status and Trends of the Nation's Biological Resources". This chapter provides information on: the origin and magnitude of the non-indigenous species problem in the U. S.; the loss of biodiversity and ecosystem changes due to invasions, the threats to parks and biota, the economic consequences of successful non-indigenous species, federal laws on invasive non-indigenous species, and the future direction of this issue.

Keywords: biodiversity, laws

Terrestrial Invasive Plants

Alien Plant Invaders of Natural Areas

URL: <http://www.nps.gov/plants/alien/>

Provides information (fact sheets) on invasive alien (exotic, non-native) plants in natural areas around the United States. It also provides background information on the serious threat and impact of invasive species on the flora, fauna and natural ecosystems of the United States.

Contact: Jill Swearingen: mailto:jill_swearingen@nps.gov?Subject=Invasive Species

Keywords: exotic plants, United States, flora, fauna, natural ecosystems

The California Exotic Pest Plant Council (CalEPPC)

URL: <http://www.caleppc.org/>

The entire 1999 Exotic Pest Plant list is available in PDF format. Also available in HTML format are subsets of this list: (1) A-1 Most Invasive Wildland Pest Plants, Widespread, (2) A-2 Most Invasive Wildland Pest Plants, Regional, (3) B Wildland Pest Plants of Lesser Invasiveness, (4) RED ALERT Species with potential to spread explosively but infestations currently small or localized, (5) Need More Information, (6) Annual Grasses, and (7) Considered But Not Listed. Online version of newsletters and publications and links to related sites.

Contact: Sally Davis: sallydavis@aol.com

Keywords: pest plants, annual grasses, California

Annex 8: Some Resources of Relevance to IAS Management

Calweed Database - California Noxious Weed Control Projects Inventory (CNWCPI)

URL: <http://endeavor.des.ucdavis.edu/weeds/>

Online searchable database of information on noxious weed control projects in California. Information stored in the database includes: title and purpose of project, weed concerned, control method, lead agency, and other relevant data. Users can view the data by project, by targeted invasive, by county, or by control method.

Contact: Kevin Ward: kward@ucdavis.edu

Keywords: noxious weeds, eradication, control, California

Exotic Plants of the South Florida Ecosystem

URL: <http://regionalconservation.org/ircs/index.cfm>

Hosted by the Institute for Regional Conservation, this database presents lists of exotic plant taxa on conservation lands in a 19 county area defined as the South Florida Ecosystem by the U.S. Fish and Wildlife Service. It contains over 3,100 sight records of infestations of EPPC Category I and Category II species in Florida public lands and waters. Nearly all of the records are from local, state, and federal parks and preserves; a few records document infestations in regularly disturbed public lands such as highway or utility rights-of-way. Natural area managers and other veteran observers of Florida's natural landscapes submit these records, with many supported further by voucher specimens housed in local or regional herbaria for future reference and verification.

Contact: George D. Gann, Keith A. Bradley, Steven W. Woodmansee

Keywords: exotic plants

Florida Exotic Pest Plant Council

URL: <http://www.fleppc.org/>

Information includes: publications, a list of Florida's most invasive plants (available in English and in Spanish), distribution maps of species that invade and disrupt native plant communities in Florida (referred to as Category I in the list), management plans for Brazilian pepper and *Melaleuca*, exotic plant control guides, and links to related information and sites.

Contact: Tony Pernas: tony_pernas@nps.gov

Keywords: Florida, control, management, Brazillian pepper, Melaleuca

Illinois Plant Information Network (ILPIN)

URL: <http://www.fs.fed.us/ne/delaware/ilpin/ilpin.html>

Host: Illinois Natural History Survey; U.S. Department of Agriculture, Forest Service

Scope: ILPIN was designed to provide many different types of information about ALL of the vascular plant taxa found in Illinois. At this site, you can search on a species (by scientific or common name), and retrieve all the information we have compiled on the species, as well as a map of its known distribution among the counties in Illinois. Includes Taxonomic, biologic, geographic, and ecologic information on 3209 Illinois vascular plant taxa.

Contact: liverson@fs.fed.us

Keywords: taxonomy, biology, geography, ecology

Invaders Database System

URL: <http://invader.dbs.umt.edu/>

A comprehensive database of exotic plant names and weed distribution in the five northwestern states of Washington, Oregon, Idaho, Montana and Wyoming. Two general types of query can be performed: 1) a query for distribution records for a particular species of interest and 2) a query for all species reported in a particular county, group of counties, or an entire state. The database can be adapted to cover other regions and/or provide a national/continental scale system for early detection, tracking, and strategic management of invasive species. The invaders website also provides listings of Noxious weed for the 48 contiguous US states and 6 southern tier Canadian provinces.

Contact: Peter Rice: [mailto:biompmr@selway.umt.edu?Subject=Invasive Species](mailto:biompmr@selway.umt.edu?Subject=Invasive%20Species)

Keywords: Exotic plants, weed, US states, Canadian provinces.

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Invasive Alien Plant Species of Virginia

URL: <http://www.state.va.us/~dcr/dnh/invinfo.htm>

General information on invasive species, a list of the most troublesome plant invaders for Virginia (PDF format), factsheets for each of these species (PDF format), and online booklet on managing invasive species in natural areas, parks, and small woodlands (PDF format).

Keywords: plant invaders, management, Virginia

Invasive Woody Plants in the Tropics Research Group at the University of Wales, Bangor, UK

URL: <http://www.bangor.ac.uk/~afs101/iwpt/welcome.shtml>

Provides detailed summaries of research work on the invasions of *Pittosporum undulatum* in the Blue Mountains of Jamaica and *Maesopsis eminii* in the East Usambara forests of Tanzania, a review of invasive woody plants in the tropics and sub-tropics, and recommendations for management and control.

Contact: John Healey: j.healey@bangor.ac.uk, John Hall: j.b.hall@bangor.ac.uk

Keywords: *Pittosporum undulatum*, *Maesopsis eminii*, Jamaica, Tanzania, invasive woody plants, tropics, sub-tropics

The Nature Conservancy Wildland Invasive Species Program

URL: <http://tncweeds.ucdavis.edu/>

Hosts an online searchable database of reports summarising many aspects of the weed species, including its ecology and control. The search can be done either by species' scientific name or common name. Also provided are bulletins for species which have been newly-sighted or are expanding in various regions of the United States.

Contact: bazza@ucdavis.edu

Keywords: weeds, ecology, control, United States

Pacific Island Ecosystems at Risk (PIER)

URL: <http://www.hear.org/pier>

Provides listings and descriptions of plant species that are a threat for Pacific islands ecosystems, particularly those of Micronesia and American Samoa. Also available are two on-line reports (PDF format) on invasive species in Micronesia and in American Samoa.

Contact: Jim Space: jspace@email.com

Keywords: plant species, Pacific islands, Micronesia, American Samoa

The Pacific Northwest Exotic Pest Plant Council

URL: <http://www.wnps.org/eppclet.html>

Draft of a list of exotic pest plants of greatest ecological concern in Oregon and Washington.

Contact: Sarah Reichard: reichard@u.washington.edu

Keywords: pest plants, Oregon, Washington

South Eastern Regional Association of Medical and Biological Organizations - Exotic Species

URL: <http://www.main.nc.us/SERAMBO/exotic>

Provided are lists of exotic species and their geographical location within the United States. Information is grouped into: herbaceous, grasses and rushes, shrubs, trees, vines, and species of concern.

Contact: Phillip Gibson: pgibson@wpoff.wcu.edu

Keywords: plant species, United States

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Southern African Botanical Diversity Network (SABONET)

URL: <http://www.sabonet.org/reddatalist/database.html>

Host: SABONET is a GEF (Global Environment Facility) Project implemented by the United Nations Development Programme (UNDP). South Africa's National Botanical Institute (NBI) is the Executing Agency, responsible for the overall management and administration of the project. In addition to the GEF/UNDP funding, the project is co-funded by the USAID/IUCN ROSA through the NETCAB (Regional Networking and Capacity Building Initiative) Programme.

Scope: SABONET is a capacity-building network of southern African herbaria and botanic gardens with the objective of developing local botanical expertise. The ten countries participating in SABONET are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe; these countries cover an area of some 6 million square kilometres.

Contact: nrn@nbipre.nbi.ac.za

Keywords: taxonomy, biodiversity

USDA APHIS Plant Protection and Quarantine - Noxious Weeds Home Page

URL: <http://www.aphis.usda.gov/ppq/weeds/>

A series of links to noxious weed information and related sites on the web.

Contact: alan.v.tasker@usda.gov

Keywords: non-indigenous, noxious, weeds

The Virginia Native Plant Society: Invasive Alien Plant Species in Virginia

URL: <http://www.vnps.org/invasive.html>

Hosts a list of some of the more troublesome invasive non-native plants in Virginia. Fact sheets (which provide plant description, information on habitat, threat and control methods) are available for selected plants. Also available is a more complete list.

Contact: Richard Moss: rmoss@richmond.infi.net

Keywords: invasive non-native plants, control, Virginia

Weeds Gone Wild

URL: <http://www.nps.gov/plants/alien/index.htm>

Plant Conservation Alliance, Alien Plant Working Group. This site provides a compiled national list of invasive plants infesting natural areas throughout the U.S., background information on the problem of invasive species, illustrated fact sheets that include plant descriptions, native range, distribution and habitat in the U.S., management options, suggested alternative native plants, and other information, and selected links to relevant people and organizations.

Contact: jil_swearingen@nps.gov

Keywords: descriptions, native range, distribution and habitat in the U.S., management options, links

Western Weeds

URL: http://members.iinet.net.au/~weeds/western_weeds.htm

Photographs, brief descriptions and distributions are given of introduced plants in Western Australia

Contacts: rprandall@sp.agric.wa.gov.au

Keywords: Australia, weeds

PAPERS, REPORTS AND BIBLIOGRAPHIES

An Assessment of Exotic Plant Species of Rocky Mountain National Park

URL: <http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm>

Rutledge, Chris R. and Dr. Terry McLendon. No Year. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97pp. Northern Prairie Wildlife Research Center Home Page.

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An Explosion in Slow Motion: Noxious Weeds and Invasive Alien Plants on Grazing Lands

URL: <http://www.forages.css.orst.edu/Organizations/GLF/GLF8REP.html>

Proceedings from the Eighth Grazing Lands Forum on the effects of invasive plants and noxious weeds on grazing lands in the United States.

Keywords: Grazing lands, invasive plants, noxious weeds

An Introduction to Common Exotic Species to British Columbia's Ecosystems: plants you know, but didn't know they didn't belong

URL: http://www.ucfv.bc.ca/biology/Biol210/1999/Exotic/Exotic_plant.htm

Information on the most prevalent exotic plants that can be found in British Columbia's forests i.e. Himalayan blackberry (*Rubus discolor*), Canada thistle (*Cirsium arvense*), Scotch broom (*Cytisus scoparius*) and Woody nightshade (*Solanum dulcamara*).

Keywords: Himalayan blackberry (*Rubus discolor*), Canada Thistle (*Cirsium arvense*), Scotch broom (*Cytisus scoparius*), Woody nightshade (*Solanum dulcamara*), British Columbia

Control of Invasive Exotic Plants in the Great Plains

URL: <http://www.npwrc.usgs.gov/resource/literatr/exotic/exotic.htm>

Larson, Diane and Kristin Freitag. 1996. Control of invasive exotic plants in the Great Plains annotated bibliography. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page.

<http://www.npwrc.usgs.gov/resource/literatr/exotic/exotic.htm> (Version 15DEC98). Provides complete citations, brief overviews on the control technique used and whether it was successful.

Contact: Diane Larson: Diane_Larson@usgs.gov

Keywords: invasive plants, Great Plains, United States

The European Weed Research Society (EWRS)

URL: <http://www.ewrs.ac.uk/>

Information about the EWRS Weed Research Journal and on-line recent issues of the EWRS newsletter. Links to related sites.

Contact: John Cussans: John.Cussans@bbsrc.ac.uk

Keywords: weed

Exotic Plant Management

URL: <http://www.nps.gov/redw/exotics.htm>

A management plan for exotic plants for the Redwood National and State Parks, based on National Park Service guidelines for natural resource management and integrated pest management procedures. Includes a list of exotic plant species in the Redwood and State Parks.

Contact: James_H._Popenoe@nps.gov

Keywords: management, National Park

Guide to Monitoring Exotic and Invasive Plants

URL: <http://www.cciw.ca/eman-temp/research/protocols/exotic/intro.html>

Provides useful information on invasive plants and aimed at raising awareness within the naturalist communities of the impact of invasive plants on natural habitats and Canadian biodiversity. It calls upon these communities to participate in the process of recording the presence, spread and impact of exotic plants on natural habitats. The guide was prepared by Erich Haber for the Ecological Monitoring and Assessment Network Environment Canada.

Keywords: Canada, monitoring

Hawaiian Alien Plant Studies, University of Hawaii, Botany Department

URL: http://www.botany.hawaii.edu/faculty/cw_smith/aliens.htm

Link to a report "Impact of alien plants on Hawaii's biota" by Clifford W. Smith concerning issues related to the biology and control of alien plant species in Hawaii. Also provides links to www pages featuring alien plant species that are among the greatest threats to Hawaiian biota.

Contact: Clifford W. Smith: cliff@hawaii.edu

Keywords: Hawaii, alien plants, control, biology

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The Introduction of Non-native Plants into Massachusetts

URL: <http://omega.cc.umb.edu/~conne/jennjim/intro.html>

A trip through history for 14 plants introduced into Massachusetts. A description is given for each species along with an animated map showing its distribution over time.

Contact: Jennifer Forman: Jennifer.Forman@umb.edu

Keywords: Massachusetts, introduced plants, distribution

Invasive Grass Species in Southern Africa

URL: <http://www.nioo.knaw.nl/cto/invass/>

European Union project to study the invasiveness of a perennial soil pathogen-sensitive grass (*Ammophila arenaria*) and an annual grass (*Cenchrus biflorus*) in Southern Africa are studied in relation to soil pathogens, mycorrhizal fungi and genetic structure.

Contact: Wim H. van der Putten: putten@cto.nioo.knaw.nl

Keywords: soil pathogens, mycorrhizal fungi, South Africa

Plant Protection Society of Western Australia

URL: <http://users.wantree.com.au/~weeds/>

General information on the aims of the society, online copy of the "Western Weeds", a guide to the weeds of Western Australia, and an extensive list of links to related sites.

Contact: Rod Randall

Keywords: Western Australia, weeds

Terrestrial Invasive Animals

The Diptera Site

URL: <http://www.sel.barc.usda.gov/Diptera/tephriti/tephriti.htm>

Hosted by the U.S. Department of Agriculture, Agriculture Research Service, Systematic Entomology Laboratory (SEL), this site includes the Biosystematic Database of World Diptera containing all fruit fly scientific names and related information as of 1997. A fruit fly reference database with over 5,500 entries will soon be available.

Contact: anorrbom@sel.barc.usda.gov

Keywords: taxonomy, phylogeny, distribution, host information

Invasive Mammals Bibliography

URL: <http://www.invasive-animals.org.nz/species.html>

This website is dedicated to providing scientific information on the world's invasive mammals. We have compiled bibliographic databases of published research, including some abstracts.

Contact: sarre@aerg.canberra.edu.au or cmking@waikato.ac.nz

Keywords: horses, possums, stoats, weasels or ermines

Social Insects World Wide Web

URL: http://research.amnh.org/entomology/social_insects/

The Social Insects World Wide Web (SIWeb) will be providing answers to questions such as on the identification of social insects, on the knowledge of a particular taxon (e.g. species, genus) or on what's known about a particular geographic area. Although it is basically a scientific instrument, access for a wider audience such as the casual browser or somebody going out for some education will be developed as well. There are also links to many other sources of information on social insects.

Contact: agosti@amnh.org

Keywords: social insects, global

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The Texas Imported Fire Ant Research and Management Plan

URL: <http://fireant.tamu.edu/index.html>

A website designed to help find long-term solutions to Texas' imported fire ant problem and to educate people on the best currently available methods to control, not eradicate, these pests. Includes biology, identification, history, habitat, impacts and information on native ants as well as a [list of experts](#) for management advice.

Contact: b-drees@tamu.edu

Keywords: red imported fire ant

USDA-Animal and Plant Health Inspection Service - Information Management System for Invasive Species

URL: <http://www.invasivespecies.org/>

Hosts three searchable databases of: (1) plant pests; (2) invasive plants and (3) North American non-indigenous arthropods.

Contact: Kenneth R. Lakin: Kenneth.R.Lakin@usda.gov

Keywords: non-indigenous arthropods, pest plants, North America

Aquatic Invasive Plants

Aquatic Invasions Research Directory (AIRD)

URL: <http://invasions.si.edu/aird.htm>

Hosted by the Smithsonian Environmental Research Center (SERC), the Directory is an Internet-based, searchable database containing up to the minute information on people, research, technology, policy, and management issues relevant to aquatic invasions. The scope of the Directory falls into four broad areas: 1) The ecology of aquatic invasions: vectors, impacts, risk assessment and response, 2) The ecology of ballast water, 3) Prevention and treatment technologies, and 4) Policy and management.

Contact: murphy@serc.si.edu

Keywords: people, research, technology, policy, management, aquatic invasions

Baltic Sea Alien Species Database

URL: <http://www.ku.lt/nemo/mainnemo.htm>

Inventory of alien species in the Baltic Sea along with references related to each listed species. Hosted by the Coastal Research and Planning Institute, Klaipeda University, Lithuania the database deals with marine invertebrates, algae, plants, and fishes in the Baltic Sea region.

Contact: Sergej Olenin: s.olenin@corpi.ku.lt

Keywords: Baltic Sea, marine species, biology, vectors of introduction, spread, impacts on the environment and economy

Calweed Database - California Noxious Weed Control Projects Inventory (CNWCPI)

URL: <http://endeavor.des.ucdavis.edu/weeds/>

Online searchable database of information on noxious weed control projects in California. Information stored in the database includes: title and purpose of project, weed concerned, control method, lead agency, and other relevant data. Users can view the data by project, by targeted invasive, by county, or by control method.

Contact: Kevin Ward: kward@ucdavis.edu

Keywords: noxious weeds, eradication, control, California

Caulerpa taxifolia

URL: <http://www.com.univ-mrs.fr/basecaul>

Provides a searchable bibliography on the invasive seaweed *Caulerpa taxifolia* in the Mediterranean Sea. Site belongs to the Centre d'Océanologie de Marseille. In French.

Keywords: *Caulerpa taxifolia*, Mediterranean

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Centre for Research on Introduced Marine Pests

URL: <http://www.marine.csiro.au/CRIMP/>

The CSIRO Centre for Research on Introduced Marine Pests (CRIMP) is Australia's national centre for research on the impacts and management of introduced marine species. The Centre is located at the CSIRO Marine Laboratories in Hobart and its research activities extend to all Australian coastal regions.

Information sheets on marine introductions and marine pests in Australian waters. It also provides a list of topical technical reports and publications.

Contact: crimp@marine.csiro.au

Keywords: Australia, marine introductions, marine pests

Directory of Non-native Marine Species in British Waters

URL: <http://www.jncc.gov.uk/marine/dns/>

A database of non-native marine species in British waters hosted by the Joint Nature Conservation Committee (JNCC), United Kingdom. The website contains information on marine invertebrates, algae, and plants in the United Kingdom. Information provided for each listed species includes: date and method of introduction, origin, reasons for success, rate of spread and methods involved, distribution, factors likely to influence spread and distribution, effects on the environment, effects on commercial interests, control methods used and effectiveness, beneficial effects, and references.

Contact: Clare Eno: eno_c@jncc.gov.uk

Keywords: taxonomy, introduction, distribution, impacts, management, non-native marine species, Great Britain

Eurasian Watermilfoil Resource List

URL: <http://aquat1.ifas.ufl.edu/milfoil.html>

A list of North American based taxonomists, ecologists, management experts, and resource managers or lake association activists who have had experiences with Eurasian watermilfoil

Contact: madsenj@wes.army.mil

Keywords: expertise

Exotic Plants of the South Florida Ecosystem

URL: <http://regionalconservation.org/ircs/index.cfm>

Hosted by the Institute for Regional Conservation, this database presents lists of exotic plant taxa on conservation lands in a 19 county area defined as the South Florida Ecosystem by the U.S. Fish and Wildlife Service. It contains over 3,100 sight records of infestations of EPPC Category I and Category II species in Florida public lands and waters. Nearly all of the records are from local, state, and federal parks and preserves; a few records document infestations in regularly disturbed public lands such as highway or utility rights-of-way. Natural area managers and other veteran observers of Florida's natural landscapes submit these records, with many supported further by voucher specimens housed in local or regional herbaria for future reference and verification.

Contact: George D. Gann, Keith A. Bradley, Steven W. Woodmansee

Keywords: exotic plants

Invaders database system

URL: <http://invader.dbs.umt.edu/>

A comprehensive database of exotic plant names and weed distribution in the five northwestern states of Washington, Oregon, Idaho, Montana and Wyoming. Two general types of query can be performed: 1) a query for distribution records for a particular species of interest and 2) a query for all species reported in a particular county, group of counties, or an entire state. The database can be adapted to cover other regions and/or provide a national/continental scale system for early detection, tracking, and strategic management of invasive species. The invaders website also provides listings of Noxious weed for the 48 contiguous US states and 6 southern tier Canadian provinces. The site also includes a state/provincial noxious weeds query form, as well as a database of biocontrol measures. Researchers may also submit their own data to the database.

Contact: Peter Rice: <mailto:biompmr@selway.umt.edu?Subject=Invasive Species>

Keywords: Exotic plants, weed, US states, Canadian provinces

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National Marine and Estuarine Invasions Database (NIS)

URL: <http://invasions.si.edu/nis.htm>

The Smithsonian Environmental Research Center (SERC) database focuses on marine and estuarine alien species in U.S. waters, including organisms that occur in tidal waters of all salinities (i.e., freshwater to full marine salinities). The primary goal of this database is to describe the patterns and effects of alien species invasions in coastal communities on multiple spatial and temporal scales. Includes the Chesapeake Bay Nonindigenous Species List.

Contact: murphy@serc.si.edu

Keywords: taxonomy, invasion history, population biology, community ecology, economic impacts, references

Nonindigenous Aquatic and Selected Terrestrial Species of Florida

URL: <http://aquat1.ifas.ufl.edu/mctitle.html>

Online report by James A. McCann, Lori N. Arkin, and James D. Williams published by the University of Florida, Center for Aquatic Plants, on the introduction of non-indigenous aquatic species into Florida. Hosted by the National Biological Service, Southeastern Biological Science Center, the website contains 1996 information on the status, pathways and times of introduction, and the economic and environmental effects on the native flora and fauna of freshwater, marine, terrestrial nonindigenous species.

Contact: varamey@nervm.nerdc.ufl.edu

Keywords: Florida, freshwater, marine, terrestrial, plants, animals

Sea Grant Nonindigenous Species

URL: <http://www.sgnis.org/>

The Sea Grant Nonindigenous Species Site (SGNIS) contains a comprehensive collection of research publications and education materials produced by Sea Grant programs and other research institutions across the country on zebra mussels and other aquatic nuisance species. All materials available through this home page have either appeared in professional science journals or have been through a rigorous scientific review to ensure the quality of the information provided. Links are provided to other sites that also focus on nonindigenous species.

Contact: wheeler@uiuc.edu

Keywords: aquatic nuisance species

University of Florida Center for Aquatic and Invasive Plants

URL: <http://plants.ifas.ufl.edu/welcome.html>

Provides information on how to access and search the Aquatic, Wetland and Invasive Plant Information Retrieval System (APIRS). This system maintains a bibliographic database on freshwater aquatic and wetland plants as well as terrestrial and aquatic plants. There are more than 51,000 research articles, books, and reports on aquatic plant ecology, physiology, utilization and control. This site also provides information on the APIRS products and services, on-line *Aquaphyte* newsletter, images and description of some selected plants, links to material on aquatic, wetland and invasive plants and their management, a link to the Federal Invasive Species Advisory Committee, a series of on-line news articles on aquatic invasive species and links to related sites.

Contact: Victor Ramey: varamey@nervm.nerdc.ufl.edu

Keyword: invasive plants, freshwater plants, wetland plants, management, control

USGS - Non-indigenous Aquatic Species

URL: <http://nas.er.usgs.gov/>

On-line queries, spatial data sets, scientific reports, and general information on non-indigenous aquatic species in the United States are available on this site. The USGS non-indigenous aquatic species database holds data on vertebrates, invertebrates, algae, and plants.

Contact: Pam Fuller: Pam_Fuller@usgs.gov

Keywords: non-indigenous aquatic species, vertebrates, invertebrates, algae, plants

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Western Weeds

URL: http://members.iinet.net.au/~weeds/western_weeds.htm

Photographs, brief descriptions and distributions are given of introduced plants in Western Australia

Contacts: rprandall@sp.agric.wa.gov.au

Keywords: Australia, weeds

The Working for Water Programme

URL: <http://www.dwaf.gov.za/wfw/>

Information on invasive alien plants in South Africa. Information provided includes: the species of concern, biological control, legislation, secondary industries.

Contact: Karoline Hanks: hanks@dwaf-wcp.wcape.gov.za

Keywords: biological control, legislation, alien plants, South Africa

PAPERS, REPORTS AND BIBLIOGRAPHIES

Biological Study Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta

URL: <http://elib.cs.berkeley.edu/TR/ELIB:701>

A scanned version of a report by Andrew N. Cohen, Energy and Resources Group, University of California at Berkeley and James T. Carlton, Maritime Studies, Williams College-Mystic Seaport. This document can be viewed and searched online.

Contact: www@elib.cs.berkeley.edu

Annex 9: IUCN & GISP Publications on IAS

IUCN Publications

General

Invaders from Planet Earth. World Conservation, Vol. 28, No. 4 and Vol. 29, No. 1 (Double issue), 1998, 63pp.

Lowe S. J., M. Browne and S. Boudjelas and M. De Poorter 2000. 100 of the World's Worst Invasive Alien Species. Published by the IUCN/SSC Invasive Species Specialist Group (ISSG), Auckland, New Zealand. Also, available on-line at: (www.issg.org/booklet.pdf)

McNeely J. A. (2001). An introduction to the human dimensions of invasive alien species. Also, available on-line at: <http://www.iucn.org/biodiversityday/mcneelyhuman.html>

Veitch C. R. and M. N. Clout (eds.) 2002. Turning the tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. vii + 414pp. Copies can be obtained from ISSG: <http://www.issg.org/Eradicat.html>

Policy

[Guidelines for the Prevention of Biodiversity Loss caused by Alien Invasive Species.](#)

Prepared by the IUCN/SSC Invasive Species Specialist Group (ISSG) and approved by the 51st Meeting of the IUCN Council, Gland Switzerland, February 2000. This publication is also available in [French](#) and [Spanish](#). Hardcopies (English version only) from: [ISSG](#)

Shine S., N. Williams and L. Gündling (2000). A Guide to Designing Legal Institutional Frameworks on Alien Invasive Species. IUCN, Gland, Switzerland, Cambridge and Bonn. xvi + 138pp. Hardcopies of this publication are available in English, French and Spanish and can be obtained from: [IUCN Publications Services Unit](#).

Legal and Institutional Dimensions of Alien Invasive Species Introduction and Control. Proceedings of the Workshop on the Legal and Institutional Dimensions of Alien Invasive Species Introduction and Control. Held at the IUCN Environmental Law Centre, Godesberger Allee 108-112, Bonn, Germany 10-11 December 1999. Workshop on Mitigating the Impact of Alien/Invasive species. In: IUCN - The World Conservation Union (1999). Report of the Thirteenth Global Biodiversity Forum, San José, Costa Rica. IUCN, Gland, Switzerland and Cambridge, UK, p15-22. Available from: [IUCN Biodiversity Policy Coordination Division](#) and: [IUCN Oficina Regional para Meso-América](#)

GISP Publications

McNeely J. A. (ed.) 2001. The Great Reshuffling: Human Dimensions of Invasive Alien Species. IUCN, Gland, Switzerland and Cambridge, UK.

McNeely J. A., H. A. Mooney, L. E. Neville, P. J. Schei and J. K. Waage (eds.) 2001. A Global Strategy on Invasive Alien Species. IUCN, Gland, Switzerland and Cambridge, UK.

Mooney H. A. and R. J. Hobbs 2000. Invasive Species in a Changing World. Island Press, Washington, D.C.

Mooney H. A., J. A. McNeely, L. E. Neville, P. J. Schei and J. K. Waage (eds). Invasive Alien Species: Searching for Solutions. Island Press, Washington, D.C. (volume in preparation).

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Annex 10: Workshop Participants List

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Annex 10: Workshop Participants List

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