Topic 5: Integration of conservation and sustainable livelihoods: Terrestrial

Session Organiser: Dr Oliver Cheesman, UKOTCF Council

Integration of Conservation and Sustainable Livelihoods: Terrestrial – Introduction, Overview and Conclusions

Dr Oliver Cheesman, UKOTCF Council

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Introduction

Most of us who work in nature conservation, or related environmental fields, feel that we are contributing to the pursuit of sustainability or sustainable development, although our interpretations of these terms may differ in subtle ways. Sustainability (or sustainable development) has been defined in various ways. An influential and memorable interpretation is that given in the Brundtland Report (WCED 1987): "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Subsequently, sustainability has come to be seen more precisely in terms of the interaction of the social, economic and environmental dimensions of human endeavour (see e.g. Adams 2006). Thus, the pursuit of sustainability can be seen as the intersection of efforts to enhance the environment, the economy, and society (as described, for example, in relation to work towards sustainability in the States of Jersey - see Freeman, this volume). Various combinations of environmental, economic and social elements can be said to underpin the concept of livelihoods. The idea of sustainable livelihoods is preferred to that of sustainable development by many workers (e.g. Sneddon 2000), because it represents a more 'people-centred' approach. Sustainable livelihoods emphasises the role of local communities, and the importance of their participation in the development of strategies for natural resource management (e.g. Pound *et al.* 2003).

The international community has increasingly embraced the concept of sustainability at a global level. It is

embedded in the 1992 Convention on Biological Diversity (CBD), notably in the call for sustainable use of biodiversity and advancement of the ecosystem approach (see also CBD 2002). The 2000 Millennium Development Goals (MDGs) acknowledge the need for sustainable use of environmental resources, and sustainability took centre stage at the World Summit on Sustainable Development (WSSD) in 2002, and in the Plan of Implementation that arose from that meeting. The urgency of the need to adopt a more sustainable approach was re-emphasised by the Millennium Ecosystem Assessment (MEA) which reported in 2005, highlighting the extent and rate of global environmental degradation as a result of unsustainable exploitation of natural resources.

At a regional level too, the importance of sustainability has been increasingly recognised in recent years, not least for small island communities whose natural resources can be particularly fragile. For example, at around the same time as the Jersey Conference, the 2006 Pacific Island Forum saw renewed commitments to linking conservation and development made at the Global Island Partnership event *Beyond the Micronesia Challenge: Sustainable Livelihoods for Pacific Communities*, and 2006 also saw at least two major conferences on sustainable tourism held in the Caribbean region. At a national level, sustainability is increasingly integrated into country plans and strategies, including those addressing biodiversity, environmental management and economic development. In the context of the UKOTs, sustainability is an important aspiration of most, if not all, of the Environment Charters.

Despite the apparently enthusiastic adoption of the principles of sustainability, sustainable development and sustainable livelihoods at these various scales, serious questions remain over real progress towards sustainability in practice. As Adams (2006) puts it:

"On the one hand, the twenty-first century is widely heralded as the era of sustainability, with a rainbow alliance of government, civil society and business devising novel strategies for increasing human welfare within planetary limits. On the other hand, the evidence is that the global human enterprise [is] rapidly becoming *less* sustainable and not more. Much has been achieved – but is it enough? Are global trends towards sustainability or away from it? Have the concepts of sustainability and sustainable development offered a coherent basis for change?"

Session Overview and Conclusions

Such questions are often most usefully addressed with reference to activities at a local level. The Jersey Conference session on the integration of conservation and sustainable livelihoods in terrestrial environments included four presentations, describing work from very different parts of the world, and involving very different core elements. Gordon Liddle (Government of South Georgia & the South Sandwich Islands) spoke about South Georgia, a UKOT with no indigenous population and a relatively pristine environment, where the impacts of visitors can be relatively easily managed. In this context, the concept of livelihoods is very different to that applied in most other situations. However, it remains relevant in relation to generation of income for tour operators, and fees accrued by the local government which has responsibility for environmental management in the face of a number of challenges. Bryan Naqqi Manco (Turks & Caicos National Trust) described work in the Turks & Caicos Islands, where the small communities of Middle Caicos have been key participants in the development of a biodiversity management plan, and the development of small scale, low impact eco-tourism. Indeed, the impetus for this project came from the local communities themselves. They sought to preserve their natural and cultural heritage, and to stimulate local economic activity based on an alternative model to the usual large-scale built developments (resorts) for tourists, which often appear to conflict with the protection of the local environment and culture. Dick Beales (Department for International Development, UK Government) gave an overview of the proposed airport for St Helena. This major infrastructural development project is seen by many as essential to the survival of local communities here (the human population has contracted from 5500 to 4000 in just 10 years), but has substantial implications also for local biodiversity – on the conservation of which the viability of future tourism will depend in large part. John Mauremootoo (CAB International, formerly of the Mauritius Wildlife Foundation), the 2002 winner of the prestigious Whitley Award for International Nature Conservation, described the situation in Mauritius and Rodrigues. Here, efforts have focused on mainstreaming conservation objectives (in particular, ecosystem restoration following environmental degradation brought about by alien invasive species), by linking them

to other national priorities such as watershed management. Such approaches have proven to be very effective elsewhere in leveraging additional resources for conservation, in the wider context of sustainable development (see Mauremootoo, in Topic 6 of this volume). The damage to ecosystems caused by species invasions illustrated clearly how environmental degradation can itself impact negatively on livelihoods.

Lively discussions followed each of the presentations. The session concluded that 'integration' was the key word in 'integration of conservation and sustainable livelihoods'. Opportunities needed to be grasped which reminded policy makers in particular that biodiversity was part of the solution, and which reminded those concerned with conservation that 'the human dimension' also needed to be part of their agenda. Processes which engaged all stakeholders from an early stage were most likely to succeed in these aims, and in the wider aim of integrating conservation and sustainable livelihoods. Creative solutions adapted to local needs would more likely be found where all stakeholders were engaged in the process. It was acknowledged that (eco)tourism had considerable value as a potential vehicle for the integration of conservation and sustainable livelihoods in many island situations. However, management of tourism to maximise benefits to local communities and biodiversity also presented considerable challenges (for consideration of such issues, see e.g. Pattullo 1996; Tapper 2006). The value of up-scaling and mainstreaming conservation objectives was also acknowledged, although it was recognised that this approach often appeared easier in principle than in practice.

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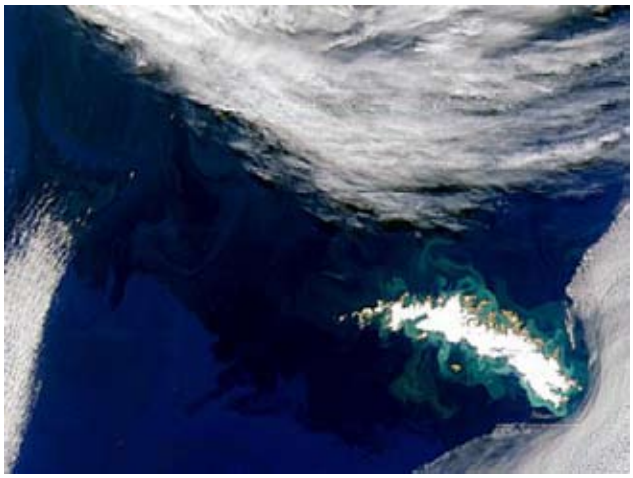
Managing the impact of tourism: lessons from South Georgia

Gordon M. Liddle, Operations Manager, Government of South Georgia and the South Sandwich Islands

Liddle, G.M. 2007. Managing the impact of tourism: lessons from South Georgia. pp 150-153 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

It is vital to have environmental baseline knowledge in order to evaluate tourist impact. This should ideally be carried out prior to the industry beginning, but can be done at any time to measure continued or changing impacts. Monitoring is then necessary to detect environmental changes. From there, one needs a process of data gathering on who is doing what and where in order that the managers can see the true cause of any changes detected. This is, we think, best done by a post-visit reporting procedure informing our tourism database. All visitors must have a permit to visit. Active management of sites of tourism is, of course, necessary and can vary enormously depending on the type of tourism and the sensitivity of the sites. Thus, individual site management plans can (and should) be created to ensure that what the visitors come to see they do not damage. All of this can work only if it is done in partnership with the tourism industry. It is one thing to try to impose regulations, but far better if the industry buys in to the process and (in effect) becomes self-regulating, as they see the economic benefits to themselves in so doing. This process is cemented by a process of education for the visitors themselves, which allows them to understand that they are valued and a positive contribution to conservation, and not just a source of general revenue. Many also are concerned about their own impact and want to be reassured that sufficient protection is in place to ensure that they are not adversely affecting the environment. It is important also to remember biosecurity.

Gordon M. Liddle, Operations Manager, Government of South Georgia and the South Sandwich Islands, Government House, Stanley, Falkland Islands



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Welcome to South Georgia

Stunningly beautiful and rugged, this island wildlife sanctuary, once visited, is not easily forgotten. Its majestic grandeur of snow covered peaks, blue glacier ice and emerald green bays, is a breathtaking sight.

South Georgia is an "Antarctic Oasis" in the cruel and stormy southern oceans and is home to thousands of penguins, sea and land birds, seals and reindeer.

Sir Ernest Shackleton lies buried in the little cemetery at Grytviken. Abandoned whaling stations rusting and rotting are a reminder South Georgia was the whaling capital of the south.

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Whaling arrives

On 16 November 1904. a Norwegian, C A Larsen, with experience of whaling in Arctic waters, established the first whaling enterprise on South Georgia at Grytviken. Larsen's enterprise was commercially very successful. Oil and by-products from one whale could fetch £2,500. His company returned a 70% dividend in its first year of trading. Huge interest in obtaining whaling licences followed. Restrictions on their issue and conditions, such as that the complete whale was to be processed, not just the blubber, were measures to try to sustain the industry. Initially only blubber was taken and the carcass discarded, resulting in beaches of bones along the coast line.

Whaling stations were established
By 1912, seven whaling stations had been established.

1904 to 1965, Grytviken was operated by Compania Argentina de Pesca to 1959 then by Albion Star and sub leased to Gyogyo Kabushiki Ltd of Japan for its last two seasons.

1907 to 1961, Stromness was initially a harbour for a moored floating factory, a shore station was built in 1912. Sandefjord Whaling Co., the Southern Whaling and Sealing Co. and Vestfold Whaling Co. operated the station to 1931. It then became a ship repair yard having been purchased by the South Georgia Company of Leith.

Nigel bonner made a record of life in the Whaling era, and in this shot -

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explore

Grytviken
Northwestern Bays
Stromness
Northeastern Bays
Willis Island
Bird Island
Cape Paradyne
Annekov Island
Greene Penninsula
Island Graveyards

Explore South Georgia

We have prepared a series of pages that take you around the island in words and pictures. We have also made a series of moving panoramas that were taken at some of the islands most beautiful locations.

To explore the island properly - you will need to have the latest Flash5 plug-in installed. This comes as standard with most browsers, but you might require a download/upgrade in order to view this feature. You will automatically be re-directed to the Macromedia site if this is neccessary.

click below to launch...








Building the TCI Biodiversity Management Plan with the local community and putting it into practice: surveying biodiversity, designing trails, recruiting guides, encouraging crafts

Bryan Naqqi Manco, Senior Conservation Officer, Turks & Caicos National Trust

Manco, B.N. 2007. Building the TCI Biodiversity Management Plan with the local community and putting it into practice: surveying biodiversity, designing trails, recruiting guides, encouraging crafts. pp 154-168 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

The *Plan for Sustainable Development and Biodiversity Management around Turks & Caicos Ramsar Site* was published and presented for public and government circulation in 2002. The Plan presents new information found during biodiversity surveys, and includes recommendations for future research, sustainable livelihoods and development on North, Middle, and East Caicos as well as other islands.

Biodiversity research provides data for protected areas management, support for the development of conservation guidelines and legislation, and material for education. National Trust field staff, TCI Government workers, and high school students are given opportunities to gain hands-on experience during field research conducted by specialists. Research outputs are incorporated into the Plan, publications for the general public, and the national curriculum.

Several projects have been involved in implementing major aspects of the recommendations in the Plan. These were resourced by a combination of local support, the work of international partners, and the UK Foreign & Commonwealth Office and Department for International Development, most recently through their joint Overseas Territories Environment Programme (OTEP). For example, the Field-roads Project upgraded 14 traditional routes into fully interpreted hiking trails, highlighting endemic plants and animals, plants of important cultural use, and historic sites in different habitats. Numbered cairns mark points of interest along the field-roads, and full-colour laminated Field-road Guide Cards, keyed to the numbered markers, provide site interpretation. Guide Cards are sold to visitors, providing maintenance funding for the field-roads.

Encouragement and training of tour guides and National Trust field staff has enhanced local capacity for sustainable development and environmental stewardship. Workshops have built better understanding between the National Trust and the tour guides, and have encouraged the local residents to take ownership of their resources for ecotourism. Support for traditional cultural crafts, protection of natural material harvest locations, and small business workshops have created a growing local craft industry. Product enhancement and development workshops led by the National Trust have improved product quality and encouraged individual specialities.

Development of a former school building on Middle Caicos has created a base of operations for biodiversity research, field-road management, capacity building and training, and environmental education. The Middle Caicos Conservation Centre will officially open in November 2006, and will feature an exhibit hall, National Trust office, research laboratory and accommodation for visiting specialists. The Conservation Centre, an idea originally proposed in 1998, represents concrete and successful implementation of the Plan for Sustainable Development and Biodiversity Management around Turks & Caicos Ramsar Site.

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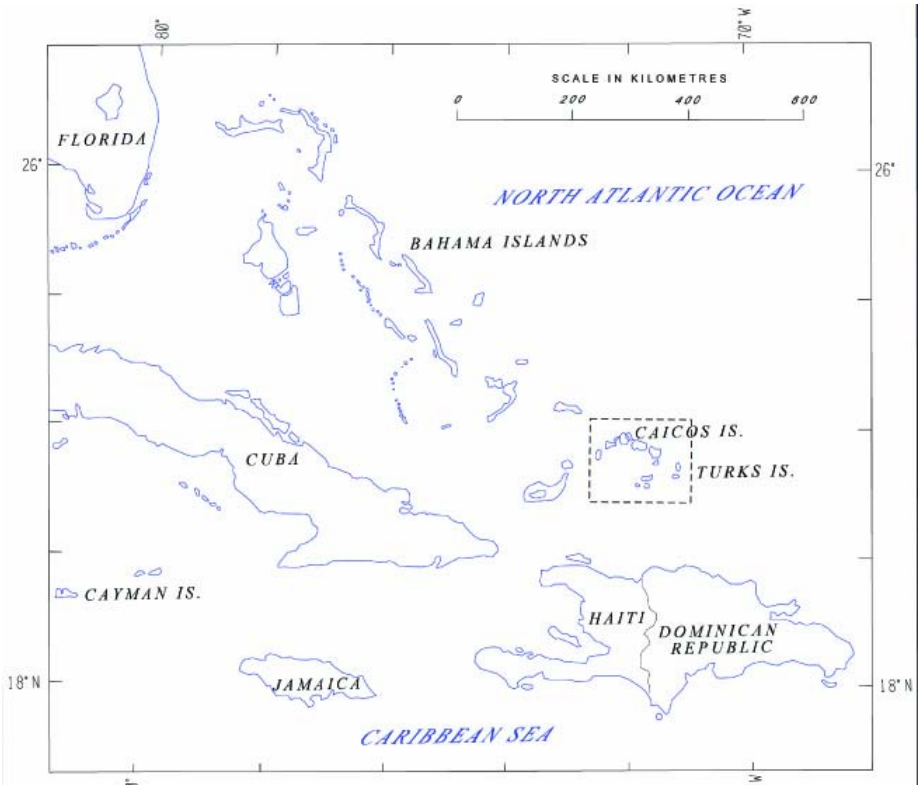
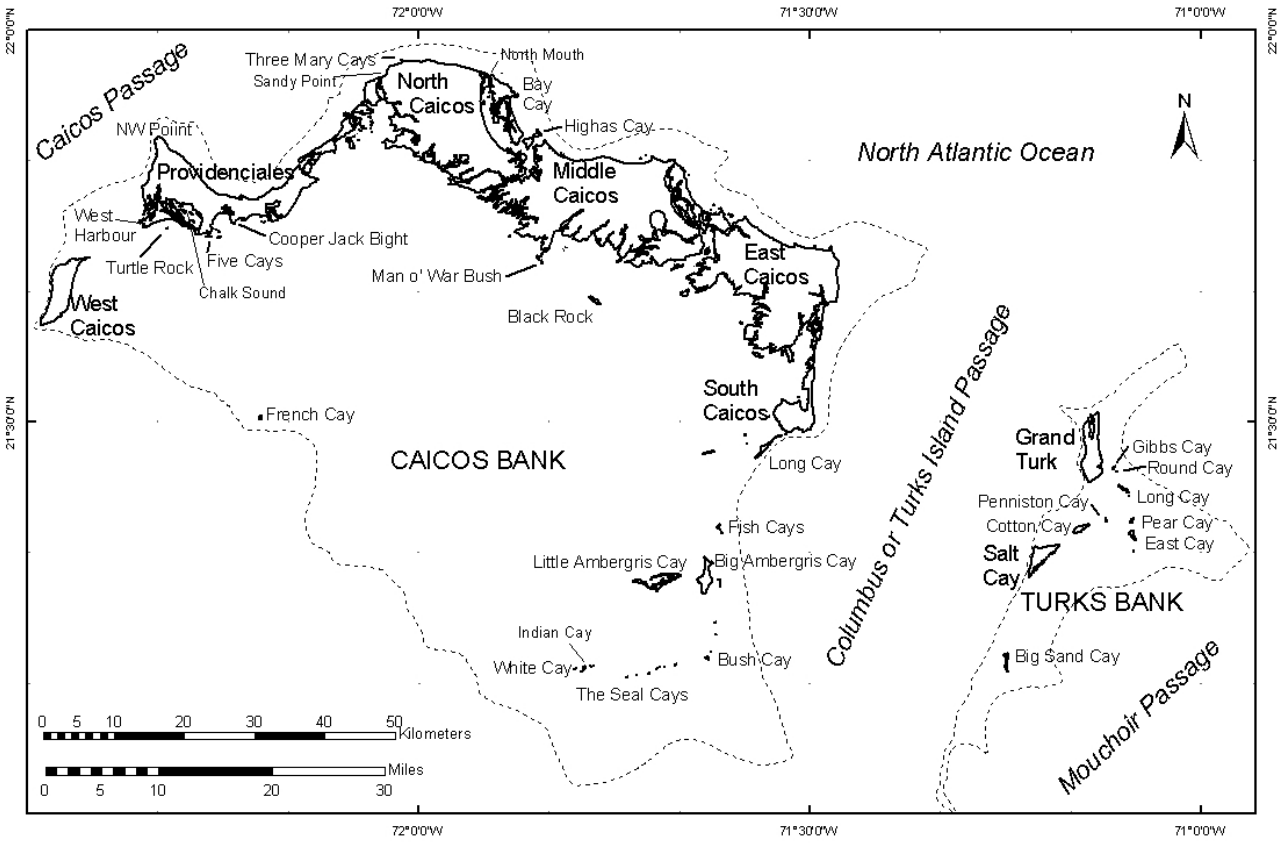
Introduction

This is the location of the Turks & Caicos Islands (TCI), a UK Overseas Territory which is geographically part of the Bahamian Archipelago but politically separate from the Bahamas.

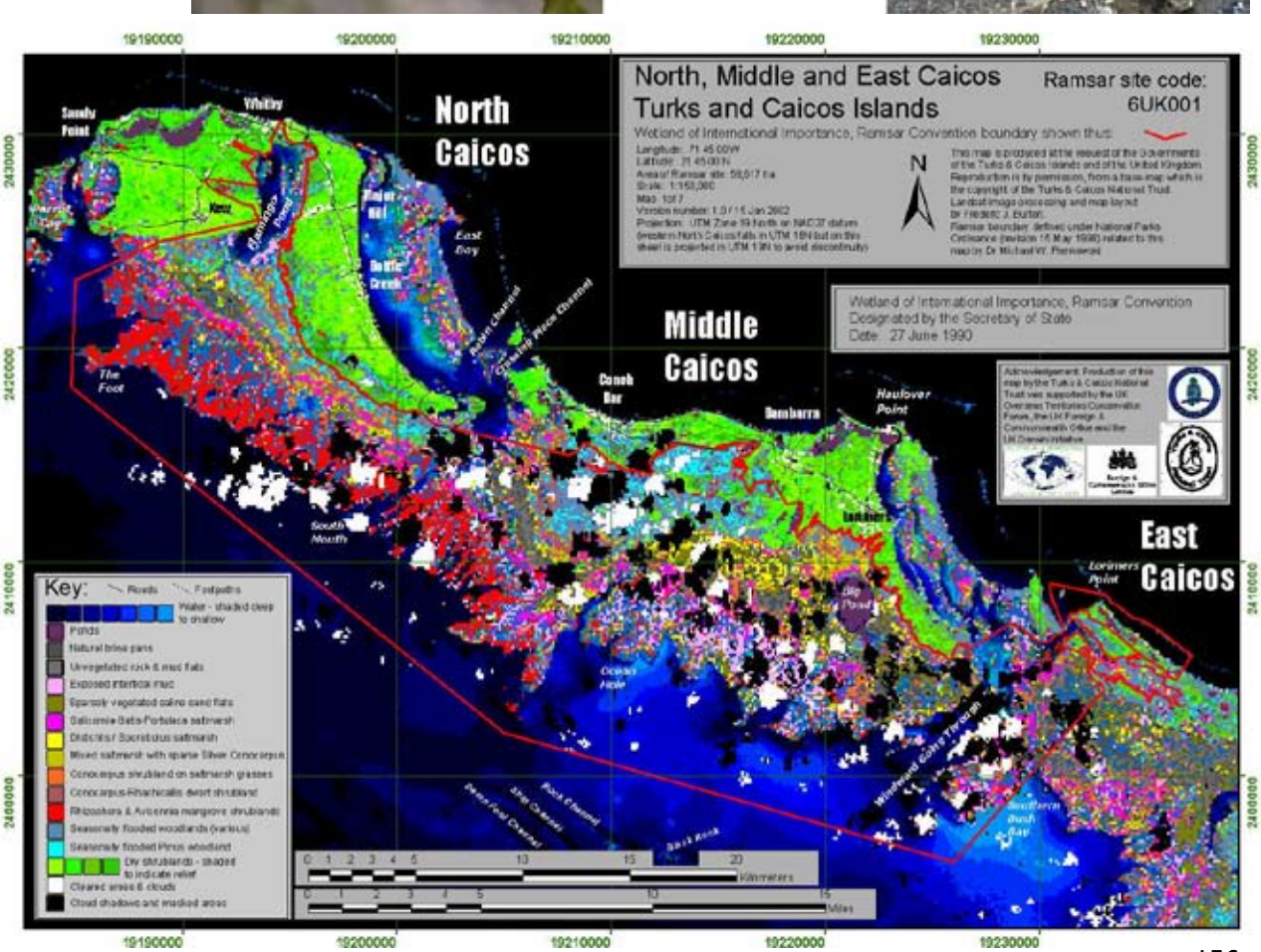
TCI comprises 9 (soon to be several more) inhabited islands, as well as over 100 other islands, cays, and rocks. These are divided into two groups, those of the Turks Bank to the east, and those of the Caicos Bank to the west. All are low-lying islands, formed principally of limestone.





The Plan for Sustainable Development and Biodiversity Management around Turks & Caicos Ramsar Site

The Turks & Caicos National Trust, the UK Overseas Territories Conservation Forum and other members of UKOTCF, including CABI Bioscience, worked with the local community and volunteer biodiversity specialists for several years to produce the *Plan for Sustainable Development and Biodiversity Management around Turks & Caicos Ramsar Site*. The *Plan* was published and presented for public and government circulation in 2002.



The *Plan* includes geo-environmental, natural, cultural, and historic baseline data on the Turks & Caicos Islands, the Ramsar Site and surrounding areas. Much of the information, particularly in relation to biodiversity, was newly collected. A habitat map (previous page) showing distribution of different vegetation types was constructed by analysis of satellite imagery and ground-truthing studies.

The three main islands covered by the Plan differ in their degree of disturbance of natural habitats. North Caicos is an agricultural island, rapidly moving towards built development. It is approximately 45 square miles with a population of around 2500. Middle Caicos is a largely undeveloped island, approximately 50 square miles with a population of about 275. East Caicos is the largest uninhabited island in the Caribbean and, like the others, is now under pressure for large-scale development.

The Plan was moulded through collaborations with the Middle Caicos community in particular. Frequent community meetings like those in the photographs above solicited valuable guidance for the project from local people, and ensured that their interests were central to the Plan.

As well as baseline information, the *Plan* includes recommendations for future research, environmental management and sustainable development for North, Middle, and East Caicos as well as other islands. Sustainable livelihoods are a particular focus for the inhabited islands.

Bee-mimic Fly on Peas n' Rice bush Melochia tomentosa

Biodiversity Research

The biodiversity research conducted under this project has provided valuable baseline data. This informs protected areas management, the development of conservation guidelines and legislation, provides material for education and popular publications, and contributes to regional and worldwide scientific study.

Five major taxa have been considered in the project's biodiversity research: plants, insects (particularly butterflies), reptiles, birds, and bats.

Heather Limonium bahamense, *endemic to TCI*


Endemic Pygmy Boa Tropidophis greenwayi, *the smallest constrictor snake in the world (left), and its main prey, the endemic Dwarf Gecko* Sphaerodactylus caicosensis

January 2005 research team at Wild Cow Run, Middle Caicos: launch point for East Caicos expeditions

Other taxa are also considered where specialist expertise is available.

Recent research sessions under the project have included fieldwork in January 2005 which focused on East Caicos, and was the first biological study of the Caribbean's largest uninhabited island in nearly 70 years. As well as work on the plant and animal groups listed above, research included cave exploration and mapping, and survey of sea turtle nesting beaches.

Redman's Long-tongue Flower Bat Monophyllus redmani *(left) and Waterhouse's Big-Eared Bat* Macrotus waterhousii

Cape Comete Hill Cave, East Caicos

Fieldwork in March-April 2006 co-ordinated by Royal Botanic Gardens (RBG) Kew focused on herbarium collections of endemic plant species, botanical field training, and survey of the introduced scale insect which is killing the national tree *Pinus caribaea* var. *bahamensis* (see above for pictures of earlier, healthy forest, current damaged forest and detail; see also Hamilton, this volume).

Fieldwork in April 2006 (below) collected 14 new species for RBG Kew's Millennium Seed Bank, and launched an on-going collection programme with plans for further international training.

Specialists leading the biodiversity studies have been recruited from top-class institutions, which have donated their staff time to the project. Independent specialists have generously contributed in a voluntary capacity. Research sessions have provided training opportunities as well as collecting data. National Trust field staff and TCI Government workers are invited to participate in the field research, thus gaining hands-on experience. High school students have also been actively involved in field activities.

Data collected during research sessions has been incorporated into the Plan, which additional information from on-going activities will be used to refine. Information from specialists' reports is also incorporated into publications for the general public, and into the National Trust's children's publications and ultimately the national curriculum. The information gathered during research sessions also underpins the interpretation material which has been developed for protected areas and ecotourism sites.

Above: British West Indies Collegiate and Department of Environment & Coastal Resources personnel participate in training in the use of dichotonous keys by an exercise in identifying the specialist scientists that they had just met at the start of the training.

Right: TCNT Education Officer leads a field trip on Silver Buttonwood Field-road based on Biodiversity Management research

High school students receiving training from visiting specialists,Stubbs Guano Cave 1, East Caicos, January 2005

Field-roads

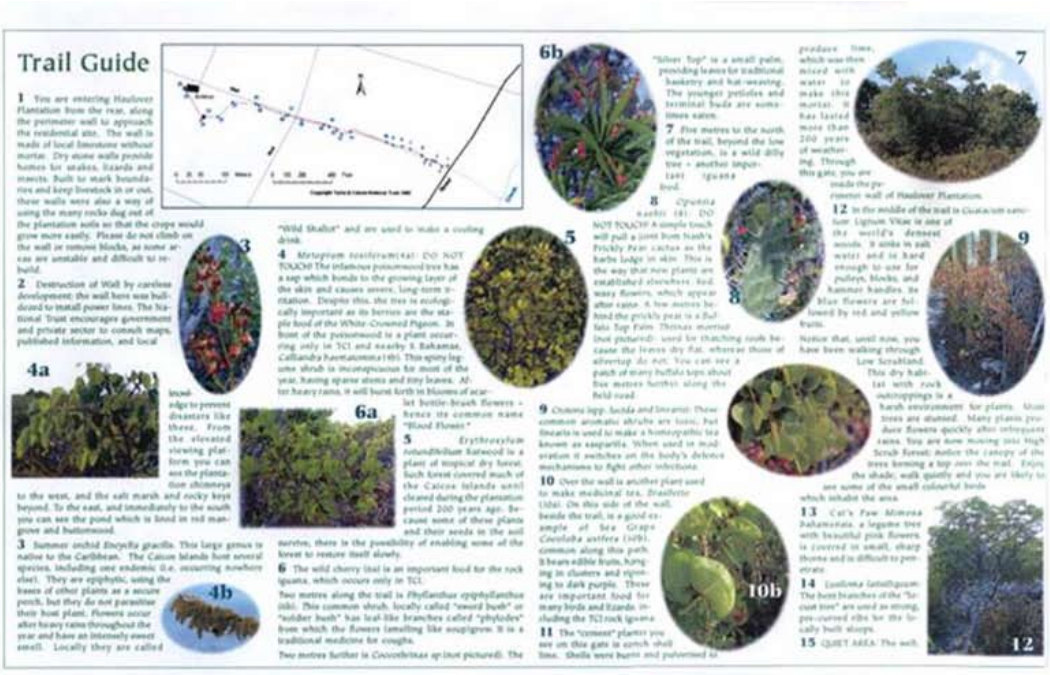
"Field-road" is a local Caicos Islands term describing a footpath through the bush, used to access agricultural areas, ponds, wells, or other important sites. The Field-roads Project upgraded traditional field-roads into fully interpreted hiking trails for ecotourism and environmental education, and implemented major aspects of the recommendations in the *Plan*. Field-roads range from short, easy walks to all-day adventure hikes and for most, the National Trust

Far left: Lorimers Village Field-road, before widening & trail bed work

Near left: Wade's Green Plantation 1: Entryway and Town, completed to Field-road Project specifications for short field-roads. Different standards apply to adventure hike field-roads.

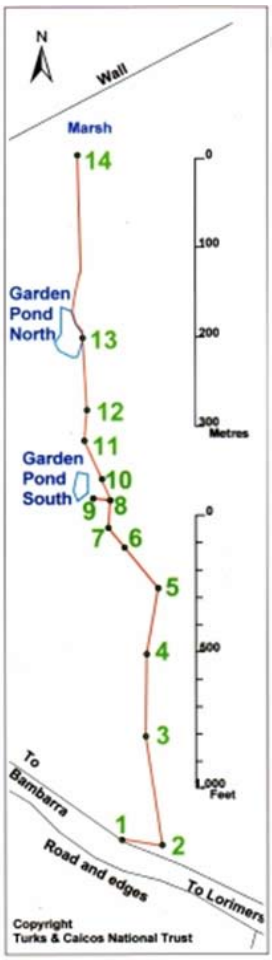
recommends a local guide for safety. Traditional limestone cairns, with plastic laminate engraved numbers, mark points of interest along the field-roads. Full-colour Guide Cards, keyed to the numbered markers, provide full site interpretation, including a map (based on aerial photos when available), along with trail conditions and area history or special interest information. Guide Cards are sold to serve as tickets to the field-road, providing funding for maintenance of the path and acting as a souvenir for visitors.

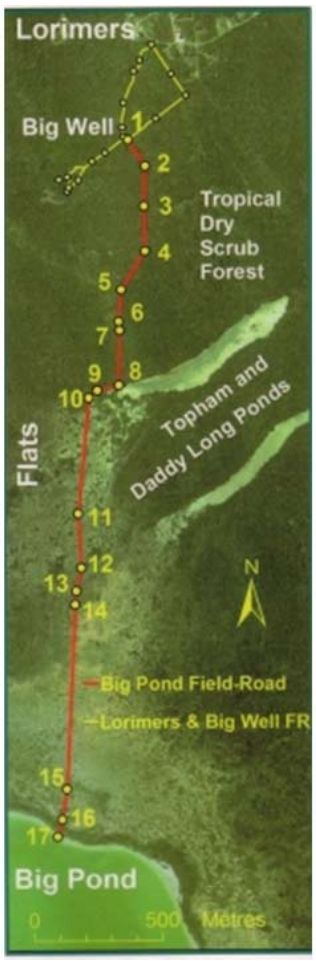
Each field-road highlights endemic plants and animals, plants of important cultural use, and historic and cultural features of interest. The field-roads cover a range of different habitat types, and pass through (or by) a number of important historic sites. The first field-roads to open were Haulover Plantation and Crossing Place Trail Part 1 on Middle Caicos in June 2004. A further 11 field-roads have been created on Middle, North, and East Caicos in subsequent years. Some, such as the two at Wade's Green Plantation (North Caicos),



Turks & Caicos National Trust

Field-road Guide Cards,
cover and inside page.





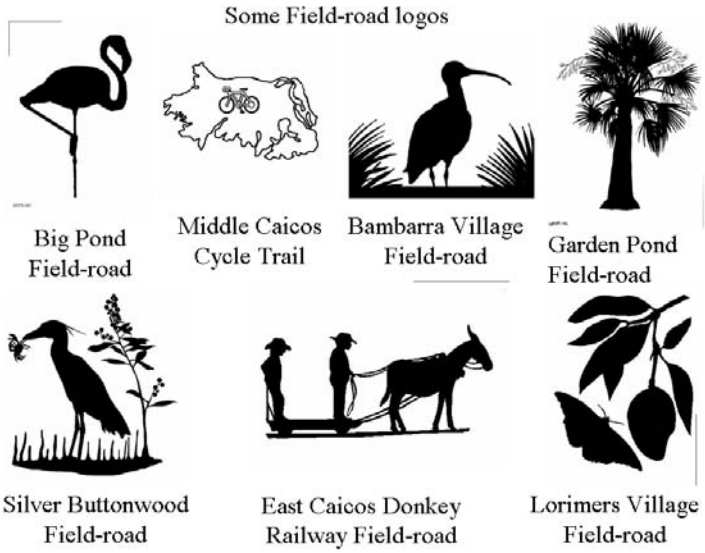
Left: Garden Pond Field-road as an example of a line map; and Big Pond Field-road:as an example of an aerial photo-based map.

Below: Field-road card in use at Wade's Green Plantation Field-road 2: Well and Dry Tropical Forest

Left: Students use a field-road card to follow Crossing Place Trail 1, Middle Caicos. Below: Turks & Caicos endemic Curly-tail Lizard or "Bugwally" Leiocephalus psammodromus, *one of several endemic species and sub-species likely to be seen on the field-roads*

and those at Cheshire Hall Plantation and Little Water Cay (Providenciales) have already become popular tourist sites.

The Field-roads Project was funded primarily by the UK Foreign & Commonwealth Office (FCO) and most recently by the joint FCO/Department for International Development (DFID) Overseas Territories Environment Programme (OTEP), together with major volunteer specialist input from UKOTCF throughout.



Sustainable livelihoods

Encouragement and training of tour guides and National Trust field staff has enhanced local capacity for sustainable development and environmental stewardship. A series of workshops and one-on-one meetings with local tour guides have proven valuable in furnishing understanding between the National Trust and the guides. The National Trust receives reports from tour guides on any unusual activity or occurrences in and around the ecotourism sites. The National Trust's implementation of the Plan's recommendations for management of Conch Bar Caves National Park on Middle Caicos has been particularly successful in establishing a sense of cooperative stewardship with the local guides. Training sessions for guides include guidance on customer service and business management, and draw on biodiversity data from the field research (with advice from specialists) as

Left above: Visitors on the field-road at Little Water Cay, famous as the site where visitors are guaranteed to see the endemic Rock Iguana (below) and their visitor fees help cover the cost of managing the reserve.

Guide training certificate for first two opened field-roads

Conch Bar Caves National Park: an important eco-tourism destination managed by Turks & Caicos National Trust

Tourism-supported local businesses and traditions

Left: Caicos sloop builder Headley Forbes at Bambarra Settlement, Middle Caicos; Middle: crab hunter Dion Outten (with Cardisoma guanhumi*) at Kew Settlement, North Caicos; Right: Alton Higgs, bush doctor at Lorimers Settlement, Middle Caicos*

needed. The ecotourism industry in Middle Caicos is steadily expanding and the National Trust's workshops and training sessions have encouraged the local residents to take ownership of their resources for ecotourism.

Small business workshops conducted by the National Trust also encourage other businesses that can profit from the field-road tourism infrastructure, such as bed & breakfast and room rental, restaurants and catering, crafts, taxis, and bike and car rental.

Support for traditional cultural crafts and local small business

Support for traditional cultural crafts, protection of locations where natural materials are harvested, and small business workshops have nurtured a growing local craft industry. The increasing ecotourism activity provides a local market for traditional craft products. The National Trust also sells traditional crafts on behalf of artisans in three locations on the tourism-dominated island of

Artisans' Small Business Enhancement Workshop at Bottle Creek Settlement, North Caicos - organised and run by Turks & Caicos National Trust

Tattyland Down Pond, North Caicos, a traditional harvest area for "dawn" Typha domingensis

Big Top Palm Sabal palmetto *used in traditional crafts*

Local crafts: straw hats & bags, "fanner-grass" baskets, toy boats, straw dolls...

Providenciales (photo above), and supplies several other retailers as well.

Workshops with traditional artisans revealed their concerns about coastal development that threatened harvest areas for craft materials. The National Trust worked with the Department of Planning to redesign a subdivision that threatened Tattyland Dawn Pond. The National Trust continues to pursue land protection for coastal and wetlands areas with populations of plants used in traditional crafts. Product enhancement and development workshops led by the National Trust have improved product quality and encouraged individual specialities.

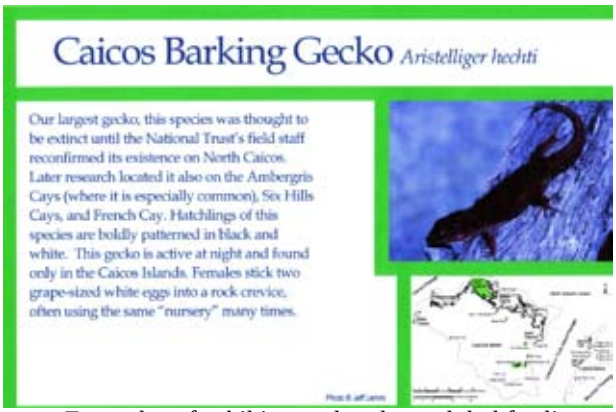
Middle Caicos Conservation Centre

Development of a building on Middle Caicos has created a base of operations for biodiversity research, field-road management, capacity building and training, and environmental education. The Middle Caicos Conservation Centre (MCCC) will officially open in November 2006, having been converted from a disused primary school with grant monies from the Turks & Caicos

MCCC building before (top right) and after (bottom) reconstruction, and interior under construction (top left)

Government's Conservation Fund, OTEP and several private benefactors, and UKOTCF volunteers.

The Conservation Centre's exhibit hall showcases exhibits explaining the natural, cultural, and historical heritage of Middle, North, and East Caicos, including artefact displays and live exhibits. The Conservation Centre's office



Examples of exhibit panels: above: label for live exhibit of Caicos Barking Gecko Aristelliger hechti*; right: Lucayans;*
following page: endemic animals and plants

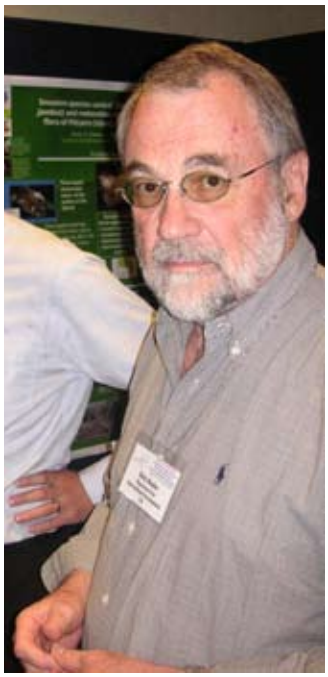
Below: Grounds of MCCC, with the main building at left.
Right: Aerial view and yard, with main building at bottom left of the grounds outlined in blue

serves as a base of operations for the National Trust in Middle Caicos, and the Centre also has a research laboratory for field research and can provide accommodation for visiting specialists.

Future plans for the Centre include outdoor exhibits and botanical displays in the large yard. The Conservation Centre, an idea originally proposed in 1998, represents a concrete and successful example of implementation of the *Plan for Sustainable Development and Biodiversity Management around Turks & Caicos Ramsar Site*.

Environmental considerations in the planning of an airport for St Helena: getting the balance right

Dick Beales, Senior Natural Resources & Environment Adviser DFID (prepared with Isabel Peters, Environmental Co-ordinator, St Helena Government)



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The decision by the St Helena and UK governments in March 2005 to build an airport at St Helena, allowing air access for the first time, is expected to bring long-term economic and social benefits to the island that would not be realised by a continuation of current arrangements for access only by sea. The prospects for the island's sustainable economic regeneration and ultimate financial self-sufficiency are expected to be enhanced largely through the development of tourism.

Among the principal attractions of St Helena as a tourist destination are its unique environmental assets and natural resources. The construction of the airport and the development of a tourism-based economy that air access is expected to stimulate, will not only carry risks but also offer opportunities to create benefits for the environment. The risks associated directly with the construction of the airport and supporting infrastructure can be assessed, and will be managed. Potential environmental benefits are emerging as a result of the sharpened focus on environmental issues that the project has brought about. It is not yet possible, however, in the absence of any firm commercial proposals, to assess the possible wider environmental and social effects of generated development, including that in the tourism sector, other than in general terms.

Topographical constraints have dictated that the runway be located on the eastern edge of Prosperous Bay Plain, an environmentally sensitive area containing a unique assemblage of endemic invertebrates and a range of indigenous and endemic plant species. It is also an important habitat (among others on the island) for part of the small and declining population of the endemic St Helena Wirebird *Charadrius sanctae-helenae*.

This presentation describes how environmental considerations have been taken into account through a phased process of environmental impact assessment linked to scheme design and the procurement of a contract for its delivery. It also describes how a balance has had to be struck between the economic and social imperative of air access development and the protection (and enhancement where possible) of St Helena's precious environmental assets on which the quality of life for its residents, and its economic future, largely depend.

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Test flight over St Helena

Although Isabel Peters is associated with this presentation, she was unable to attend the conference for the reasons that underpin this issue, i.e. St Helena's isolation and infrequent ship voyages.

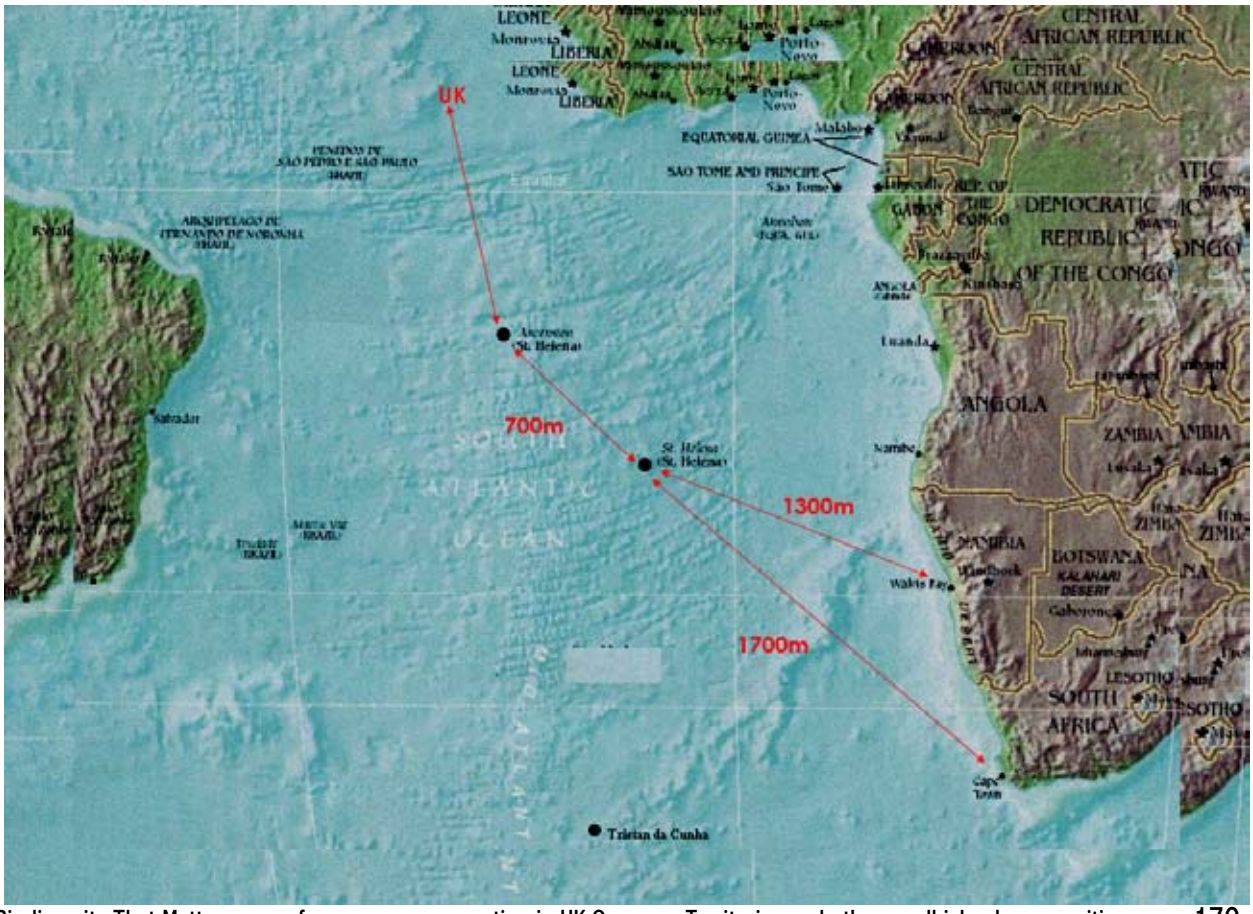
In giving the presentation, Dick Beales spoke from his perspective as natural resources and environment adviser to the St Helena Access Team. of the Department for International Development's (DFID) Overseas Territories Department.

Although the project is a highly complex one, time constraints on this presentation will allow only a somewhat superficial treatment. It is intended, therefore, given the focus of the Conference, to highlight two particular biodiversity issues.

The background to the access project is in the abstract above, but it is worth highlighting some 'givens' at the outset.

Starting points

- Air access is a social and economic imperative for the island;
- Economic regeneration and future financial sustainability are likely to lie in tourism development;
- The environment constitutes a large part of the tourism product;
- A political decision to build an airport has been taken by St Helena Government (SHG) and DFID (March 2005);
- Approval by DFID Ministers was conditional on a rigorous Environmental Impact Assessment (EIA) being undertaken;
- There is only one possible site on the island for a runway of the required length;
- There will be direct environmental impacts but these can be managed;
- There are opportunities to create environmental benefits;
- Air access has been on the island's agenda for a



RMS St Helena

long time (probably since 1947)

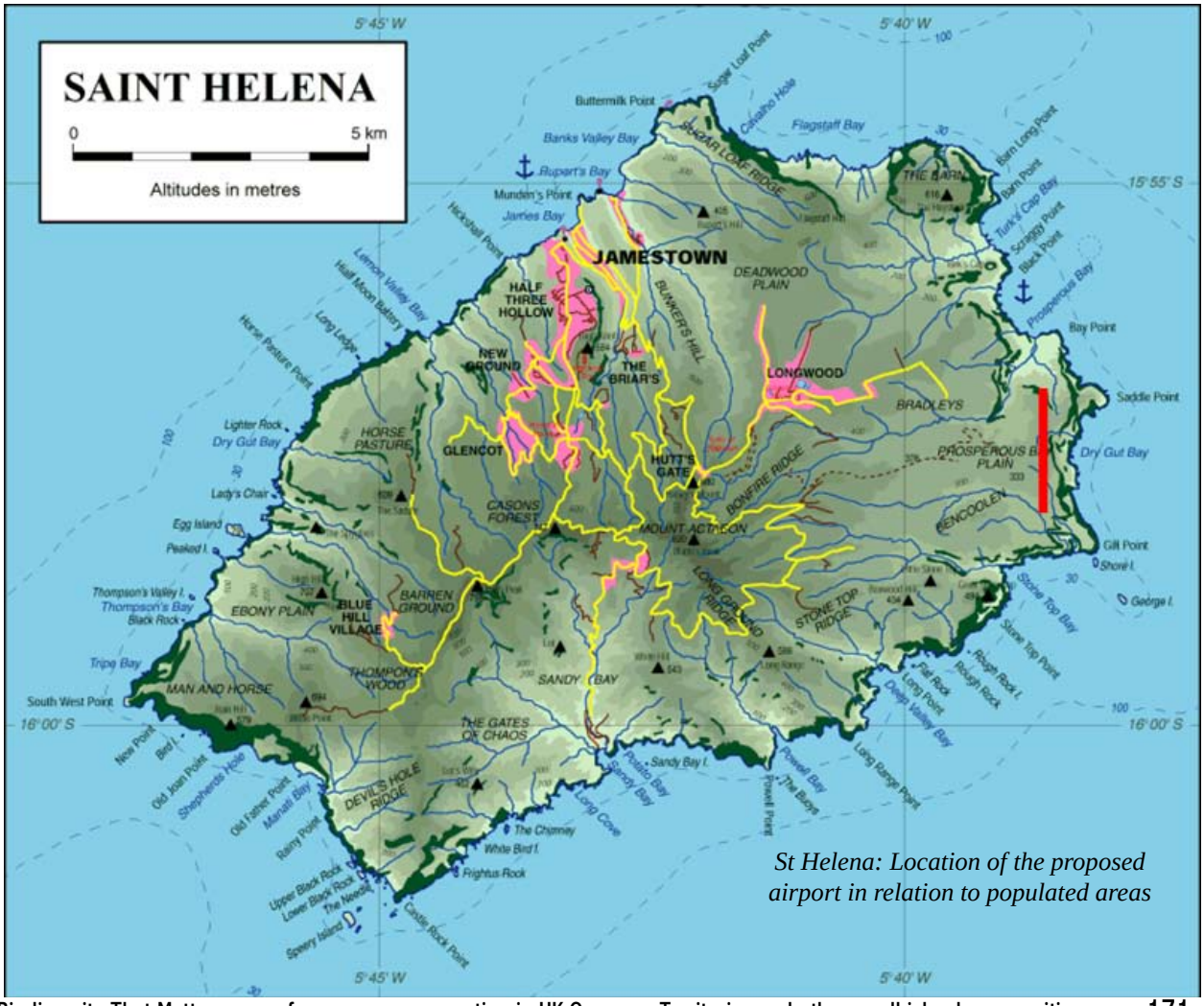
- St Helena is a much-studied island – a lot of knowledge exists
- It is not a pristine environment, having been constantly modified by human activity since the 16th Century.

St Helena

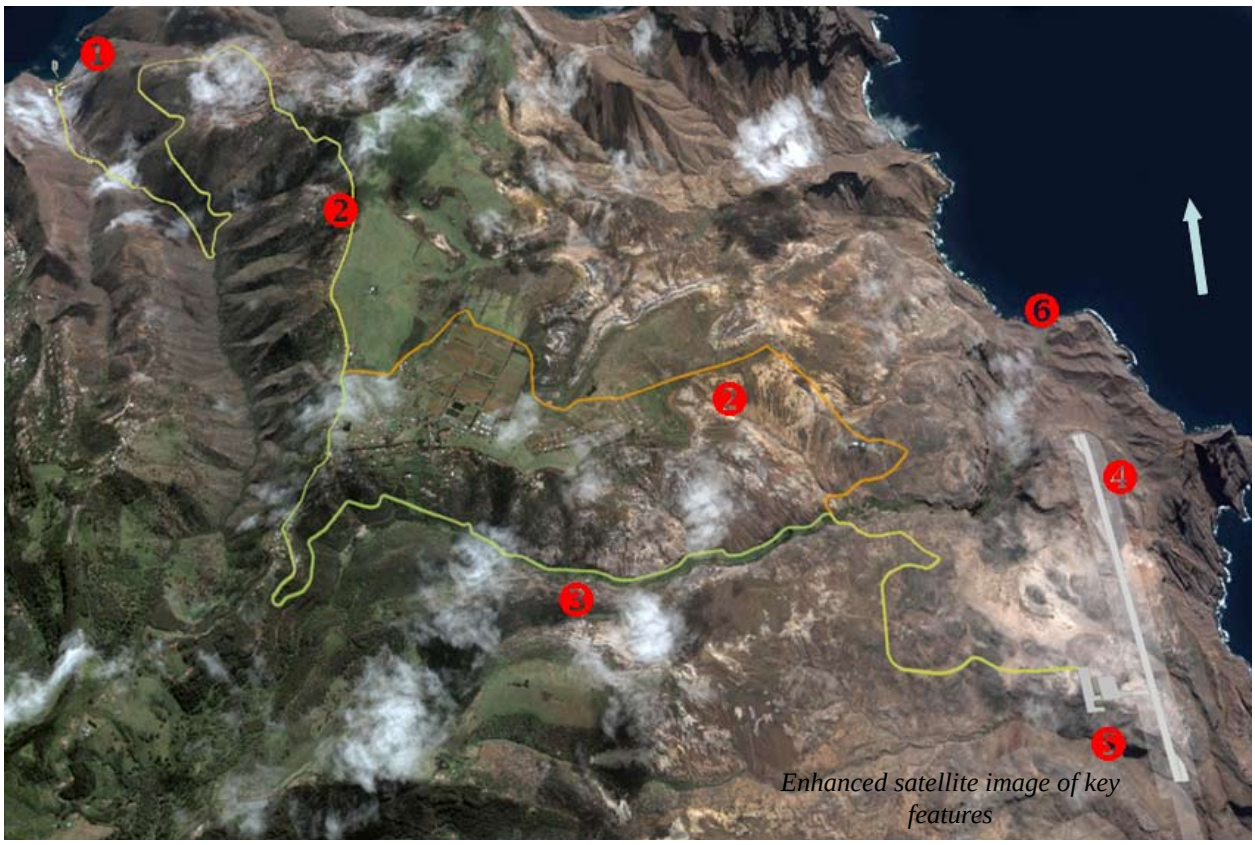
St Helena has a mid-ocean location (see map on previous page). Access is only by sea. The current - and probably the last - *RMS St Helena* (above) is a specialised cargo-passenger ship built specifically for St Helena's needs in1990. It is due to be retired around 2010. It has provided a subsidised service. However, this cannot form the basis of economic regeneration and financial sustainability.

At 122 km^2 (approximately 17 x 10 km), St Helena is roughly the same area as Jersey. The highest point is 825m above sea level (ASL). It has a population of about 4000, down from 5500 ten years ago. The main settlements are shown in pink on the map below, with the road network in yellow. The planned runway location at Prosperous Bay Plain is shown in red.

View towards Prosperous Bay Plain from the Peaks



St Helena: Location of the proposed airport in relation to populated areas



Enhanced satellite image of key features

Main components of the project

The photograph on the previous page looks northeast to the airport site at Prosperous Bay Plain, from the Peaks in the centre of the island. The Plain is at approximately 300m ASL, with cliffs to the north, east and south.

The total runway length will be 2250m. Although the Plain looks reasonably level, approximately 8 million cubic metres of rock will need to be shifted for an embankment in Dry Gut (near the southern end of the runway) to enable the full length to be realised.

The satellite image above shows the location of the key features of the project. Possible landing points for plant and construction materials are at Rupert's Bay (1) and Prosperous Bay (6). There are strong economic, technical and developmental reasons, and some environmental ones, for favouring the former. For example, it would enable the bulk fuel installation at Rupert's Bay to be moved away from the residential area, producing health and safety benefits. The haul route from the coast at Rupert's Bay would most likely follow the route from Deadwood Plain to Bottom Woods (2). While a route through Fisher's Valley (3) might be preferable in terms of Wirebird conservation, it would impinge on a proposed Wetland of International Importance under the Ramsar Convention. In the event, this option proved not technically feasible. The airport runway (4) and terminal complex (5) are shown lying to the east of the central basin (the pale-coloured area) of Prosperous Bay Plain.

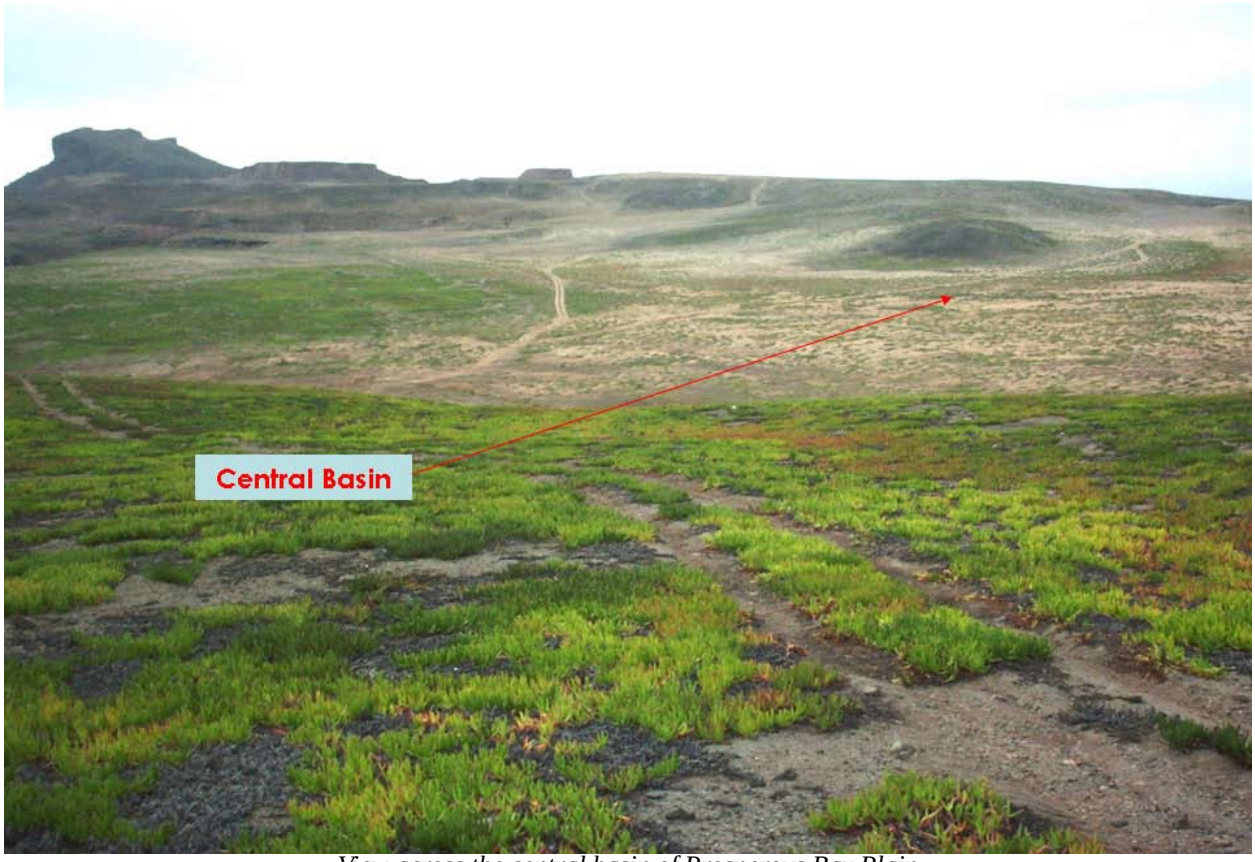
Other important elements of the airport project include:

- Inshore sea rescue
- Fire and rescue services
- Remote obstacle lighting – power/access issues
- Meteorological station – power/access issues
- Security fencing.

Key environmental issues

We will focus on two areas: Deadwood Plain and Prosperous Bay Plain. There are environmental

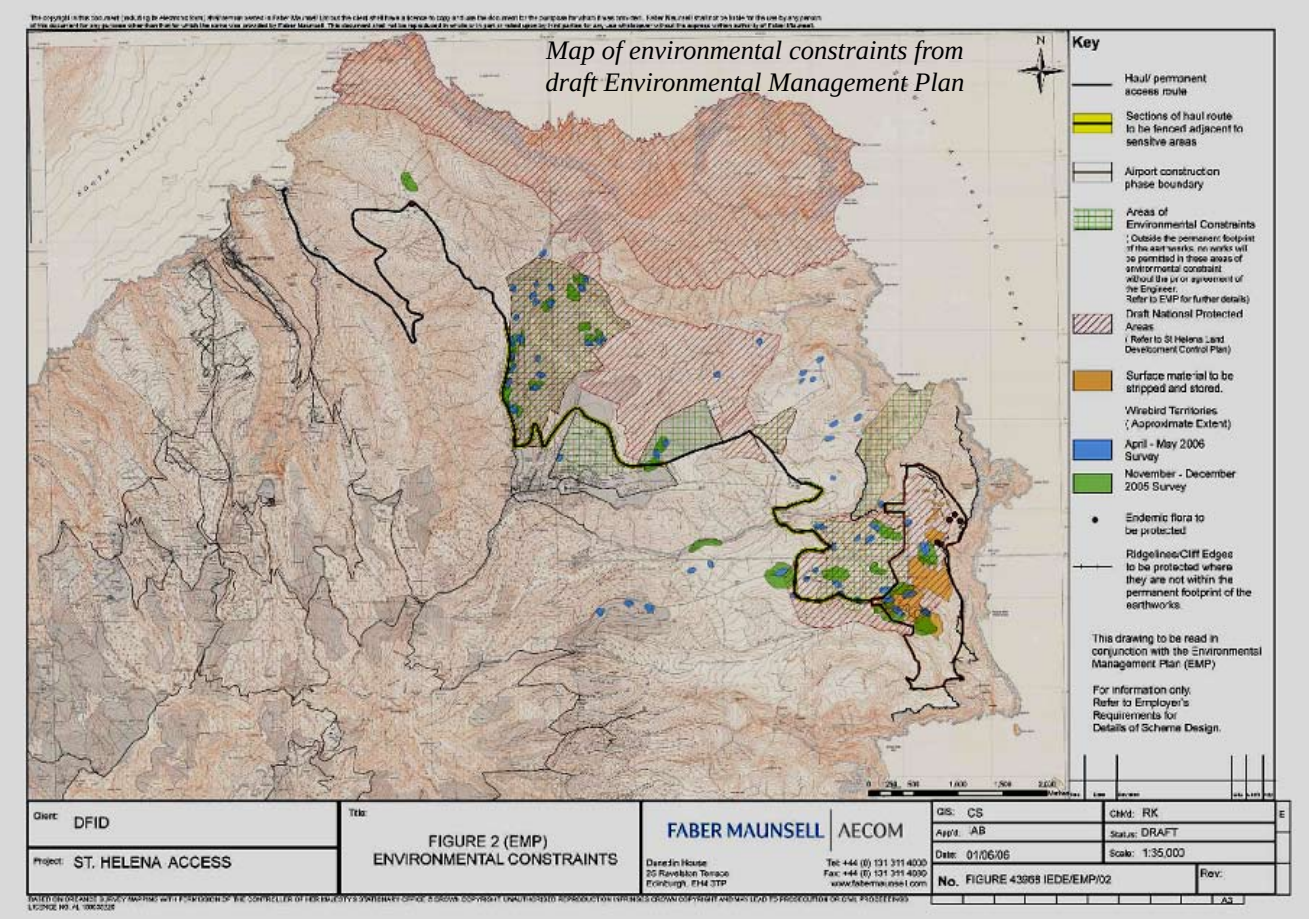

St Helena Plover or Wirebird Charadrius sanctaehelenae
(Image courtesy Mike and Ann Pienkowski)



View across the central basin of Prosperous Bay Plain

headaches here, but also opportunities for creating environmental benefits.

Deadwood Plain and adjacent areas are critically important habitat for the Wirebird. The population of about 220 adults shows a 43% decline over the past 5 years. This is considered to be due to habitat degradation through reduced grazing and invasive



plants, as well as to predation by feral cats and, possibly, mynas.

Prosperous Bay Plain is unprotected. The studies by the Ashmoles and the airport project have focused attention on the need for protection.

Philip and Myrtle Ashmole's work has confirmed the central basin of Prosperous Bay Plain as a hotspot of invertebrate endemicity (notably of spiders), with more than 20 endemic species.

It is also an important habitat (among others on the island) for the endemic Wirebird, and for several species of indigenous and endemic plants. A survey of lichens by a Dutch specialist is taking place as we speak.

The airport project offers an opportunity to bring about a long-term beneficial effect, by arresting the gradual decline on a habitat whose global biodiversity significance has only recently been fully appreciated.

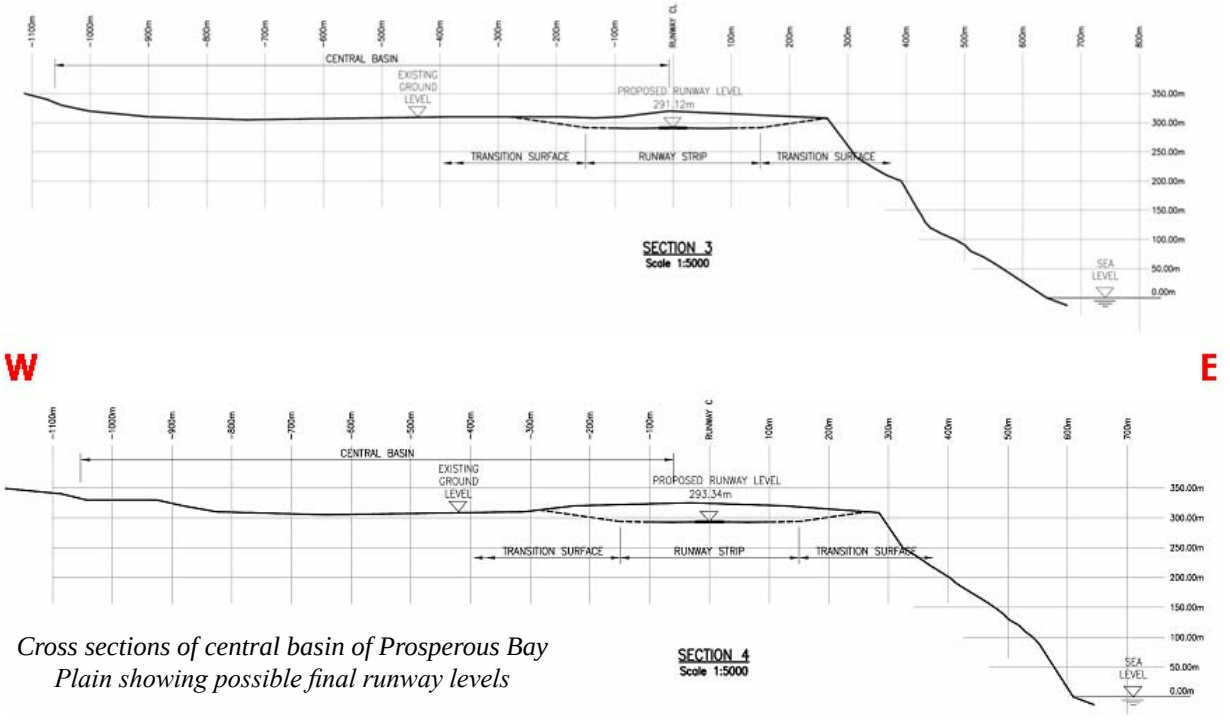
There are a number of environmental constraints to be taken into account in project planning. The airport itself will have a footprint of approximately 100 ha. The map on the previous page shows (in green crosshatch) areas of particular environmental constraints, particularly Deadwood Plain and Prosperous Bay Plain.

Wirebird territories are shown in blue (April-May 2006 survey) and green (November-December 2005 survey), resulting from the updating study commissioned by DFID from Neil McCulloch through RSPB. The sensitivity of Deadwood Plain (along the west side of which the access route runs) and the Prosperous Bay Plain area are clear.

An OTEP-funded project is helping to formulate a species action plan, involving work with RSPB, St Helena National Trust (SHNT), the St Helena Government's Agriculture and Natural Resources Department (ANRD) and others. The Air Access project will support habitat restoration elsewhere in compensation for habitat lost at Prosperous Bay Plain.

As noted above, the central basin of Prosperous Bay Plain was identified by the Ashmoles and others as an invertebrate biodiversity hotspot. Their work has already contributed to the outline design by, for example, influencing the location of the terminal. The airport works will involve the loss of 15-20% of the habitat of the central basin but it is expected that the remaining area will be afforded greater protection than it has at present. There will, however, be a change in topography, with the loss of some of the upwind protective ridge to east, which may affect the micro-climate of this desert.

The west-east sections across central basin and runway below show the lowering of the eastern part of the central basin and the ridge to the east. This will lower the level of the runway and its surrounds, in order to provide a balance of cut material along the runway sufficient to fill Dry Gut.



Cross sections of central basin of Prosperous Bay Plain showing possible final runway levels

Deadwood Plain looking north

The runway edges need to slope at 7% to meet the safety requirements of the airport regulator.

The final level of the runway surface cannot be determined until detailed design takes place. In the meantime there remains some uncertainty about likely future conditions in the central basin. Wind effect modelling studies to assess possible effects of changed dynamic processes have been completed. The results of particle analysis are awaited.

Key environmental issues

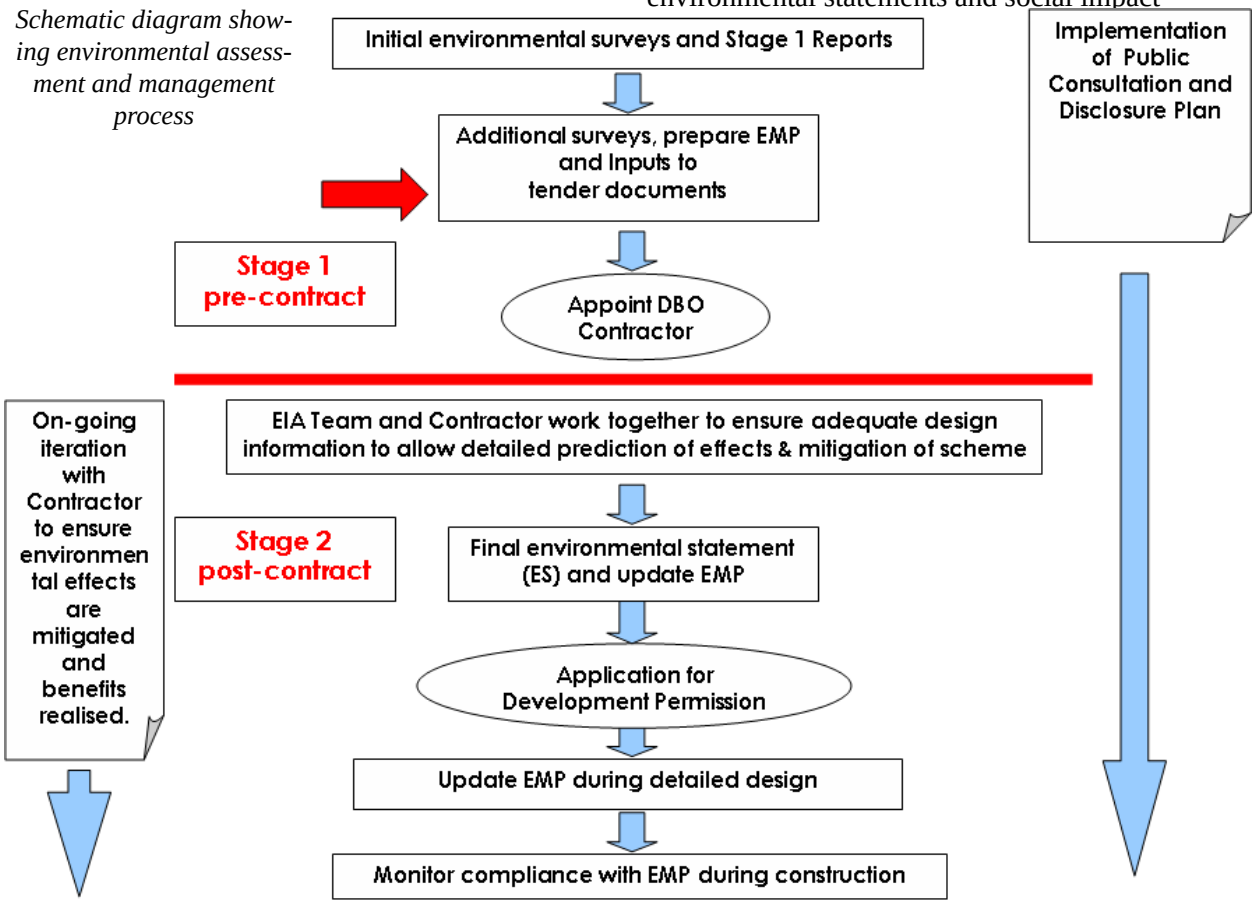
A wide range of issues is being addressed, but detailed assessment on many of these, is dependent on the level of design achieved at each stage of the Design, Build and Operate (DBO) procurement process. These issues include:

Noise and vibration
Air quality, carbon emissions, dust arisings
Effects on marine and terrestrial ecology
Effects on biodiversity
Land take and land use
Landscape and visual impact
Effects on residential, commercial, industrial, agricultural and other land uses
Disruption to users of roads, footpaths and amenity areas
Effects on surface water environment
Effects on heritage features
Waste management
Opportunities/benefits

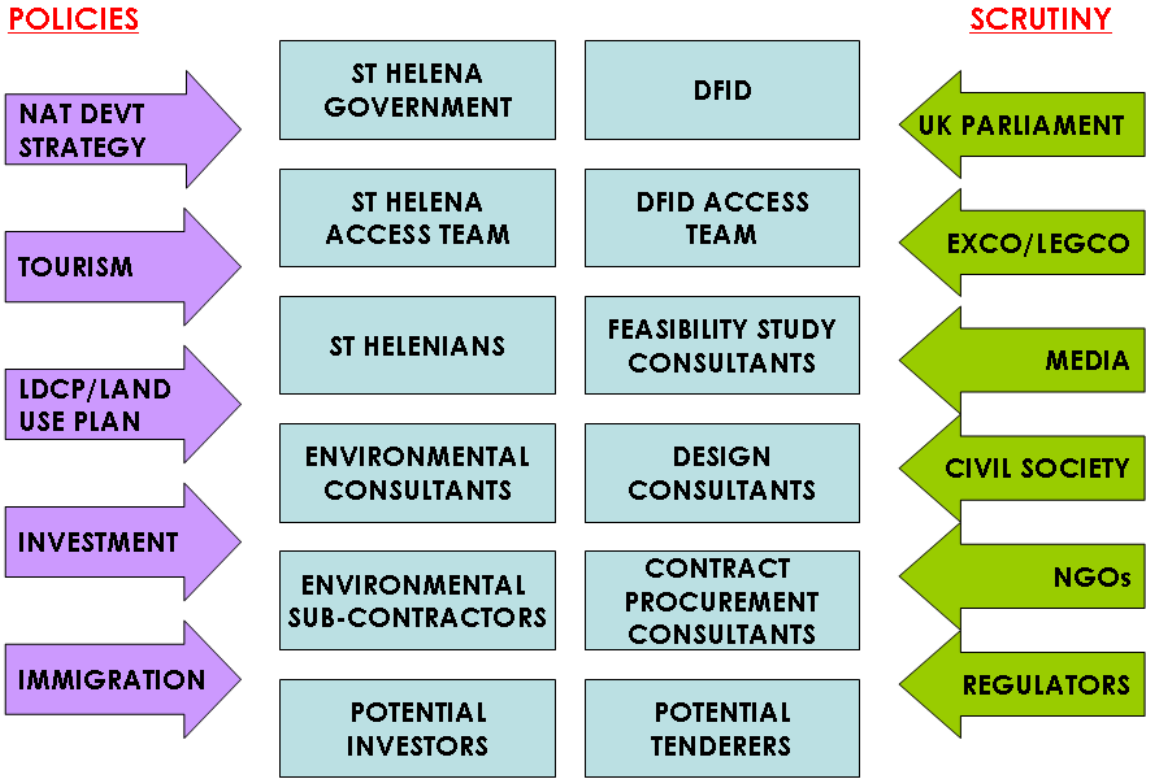
EIA process

Because there are few local standards for environmental impact assessment (EIA), the consultants have been tasked with applying international good practice in a proportionate manner and adapted to the circumstances of St Helena. The process will be generally consistent with the requirements of St Helena's Land Development Control Plan (LDCP) which requires environmental statements and social impact

Schematic diagram showing environmental assessment and management process



St Helena Access Project: policies, main players and oversight



assessments to be submitted with applications for development permission for any major scheme.

The project is required to meet the highest possible standards of environmental assessment and management. It has been agreed with the environmental consultants that the outputs of the EIA to be submitted in support of the Application for Development Permission should be defensible in terms of the normal expectations of the planning process in the UK.

The outputs will be:

- Environmental assessment reports
- Environmental Management Plan
- Public Consultation and Disclosure Plan
- Additional specialist studies and mitigation proposals
- Local skills transfer
- Compliance monitoring during construction

However, EIA is a process, not a single output. The environmental assessment process has to run alongside the DBO contract process (see diagram on previous page). The red arrow is where we are now.

The EIA is taking place:

- in the midst of a wide range of actors (see diagram above)
- against new policies being developed by SHG to meet the new challenges; and
- quite properly, under scrutiny, both internally in St Helena and externally.

We are fortunate to be able to call on the expertise of a wide range of specialists, both on St Helena and elsewhere. We are fortunate also to have been able to develop constructive dialogues even with those external specialists and commentators who – in the interests of biodiversity conservation – might prefer an airport not to be built, but who recognise that the social and economic future of the island's people is dependent on taking this major step now.

Rupert's Bay: existing infrastructure

Left:
View from Prosperous Bay Plain down to Prosperous Bay

Right:
View south across Dry Gut towards Great Stone Top

Key biodiversity and environmental issues

Sensitive Features at Rupert's Bay and the Wharf Area

Commercial Properties:
- Fish processing – includes landing stage, two processing plants all of which are essential to the island's economy
- Bulk fuel farm
- Warehousing

Coastal and Marine:
- Sensitive marine and coastal habitats and wildlife
- Coastal scenery

Rupert's Beach:
- Important beach and amenity area to remain open

Heritage interest:
- Fortification wall, Rupert's Lines
- Boer prisoner of war desalination plant, including chimney
- Banks Valley Battery

Sensitive features at Deadwood Plain and Longwood

Residential areas and community facilities:
- housing on route of haul/access road
- schools, amenity areas (Millennium Forest)
- meteorological station, landfill waste site

Footpaths and Roads:
- existing roads, paths to landmarks

Agriculture:
- arable and pastoral farming crossed by haul/access road

Heritage Interest:
- Longwood House & conservation area, Boer POW camp

Key Wirebird Habitat

(NB Since this presentation was made (October 2006), the project has been re-tendered against reference designs prepared by SHG/DFID's consultants, into which the environmental consultants have had significant input. Under the revised timetable, it is expected that a contract will be let in 2008.)

Enhanced satellite image of Longwood and Deadwood Plain

Terrestrial biodiversity conservation in Mauritius and Rodrigues: the upscaling and mainstreaming challenge

John Mauremootoo, CAB International, formerly Mauritius Wildlife Foundation

Mauremootoo, J. 2007. Terrestrial biodiversity conservation in Mauritius and Rodrigues: the upscaling and mainstreaming challenge. pp 178-191 in *Biodiversity That Matters: a conference on conservation in UK Overseas Territories and other small island communities, Jersey 6th to 12th October 2006* (ed. M. Pienkowski). UK Overseas Territories Conservation Forum, www.ukotcf.org

The terrestrial biodiversity of the Mascarene Islands (Mauritius, Rodrigues and La Réunion) exhibits high levels of endemism typical of tropical islands of their age and isolation. Introduced species have been and continue to be the main cause of extinctions in the Mascarenes since their colonization by man from the late sixteenth century. Mauritius and Rodrigues are the two major islands that make up the Republic of Mauritius. While both islands have had many documented extinctions since colonization, they can also boast of many conservation success stories in which species have been brought back from the brink of extinction by a combination of single species and habitat management. The primary focus of habitat management to date has been the intensive control of introduced species in small areas selected for their biodiversity importance. While the management of biodiversity in these areas has been successful, in most cases native biodiversity in surrounding habitats is continuing to decline due to the impact of introduced invasive species. Having saved many species from the brink of extinction, today's challenge is to increase the scale of ecosystem restoration efforts in order to make these gains sustainable. Ecosystem restoration in Mauritius and Rodrigues is a costly undertaking. In order to increase the scale of restoration efforts it will be necessary to attract increased funding. It is unlikely that finance on the scale needed can be found from traditional conservation funding sources alone. Mainstreaming conservation - the integration of conservation into priority national objectives - is a possible way of sourcing the necessary funds. Several mainstreaming possibilities for Mauritius and Rodrigues are examined and their pros and cons are summarised. Possibilities include the restoration of native forests for watershed management, the promotion of native forests as a tourist resource, and the use of forest restoration as a social welfare activity.

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1. Introduction

The Republic of Mauritius comprises the two major islands Mauritius (1865 km^2) and Rodrigues (109 km^2) and their 67 associated islets (49 islets inside and outside the lagoon around Mauritius and 18 all inside the lagoon of Rodrigues), as well as several other small Indian Ocean islands. Mauritius lies about 900 km east of Madagascar and Rodrigues a further ca. 600 km east of Mauritius. The Mascarene archipelago (Fig. 1.a) includes Mauritius and Rodrigues, together with La Réunion (politically a Département Outre Mer of France).

Concerted conservation efforts began in Mauritius about 25 years ago with intensive species recovery programmes for several bird species that were on the brink of extinction. These efforts have since expanded into further species recovery programmes for endangered vertebrates and plants, and intensive ecosystem restoration programmes of mainland and islet sites of key biodiversity importance. The methods and impressive achievements of these programmes are summarised in this paper. The next challenge for Mauritius is to scale up ecosystem conservation efforts while consolidating the gains made to date. The main areas that need to be developed in order to scale up restoration efforts centre on the management of invasive alien species and in particular invasive weeds. Possible ways in which this can be achieved and potential mechanisms for financing these programmes are outlined in this paper.

Figure 1.a. Mauritius and Rodrigues in the Indian Ocean

1.1 A Globally Significant Biodiversity

The Mascarenes stand alongside the Galapagos, New Zealand and Hawaii as archipelagos, which, by virtue of their situation, age and isolation have become homes for a fascinating flora and fauna

	Flowering plants	Birds	Reptiles
Total native taxa	685	28	19
Strict endemics	311 (45%)	15 (54%)	17 (89%)
Mascarene endemics	459 (67%)	19 (68%)	17 (89%)

Table 1: The level of endemism of selected elements of the Mauritian native biota (figures include species known or thought to be extinct)

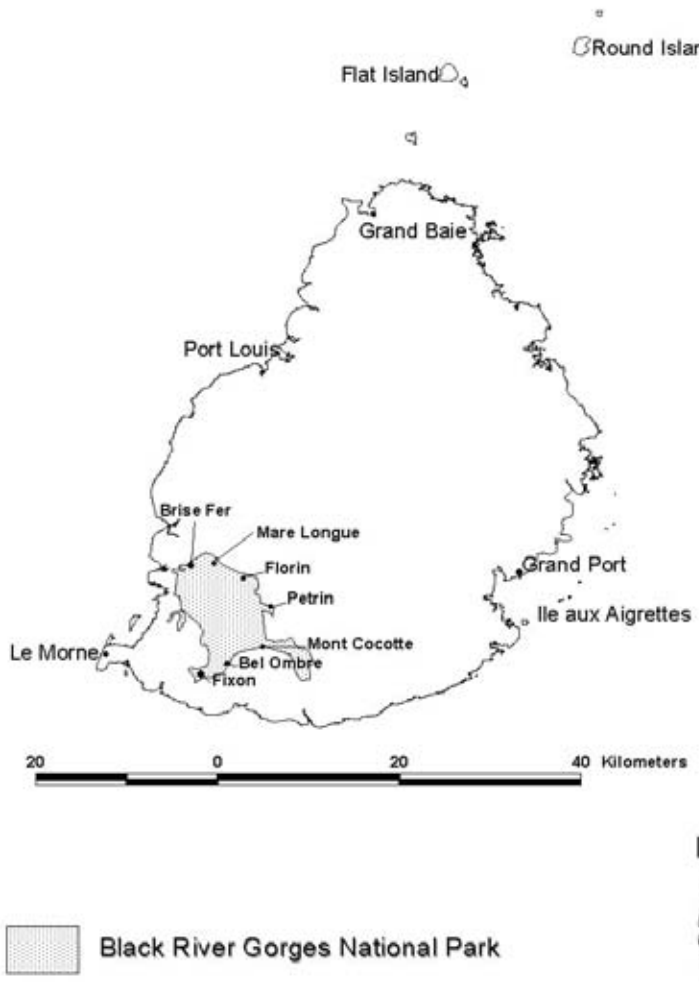

Figure 1.b. Mauritius - Sites of major biodiversity importance referred to in the text.

with many unique species. This high degree of endemism can be illustrated using the example of Mauritius (Table 1).

The high level of endemism and species diversity per unit area has resulted in the islands being identified as a Centre of Plant Diversity (CPD Site 102) by the IUCN (Strahm, 1994) and the inclusion of the Mascarenes in the Madagascar and Indian Ocean islands biodiversity hotspot (Myers et al. 2000).

1.2 Extinctions and Rarity caused by Habitat Destruction, Direct Exploitation and Alien Species Invasion

Mauritius only has about 2% of native forest remaining and even this is degrading at a rapid rate. Of its remaining 11 remaining species of land bird 9 are endangered and 105 species of flowering plant in Mauritius are considered to be Critically Endangered (sensu IUCN, 1998). In Rodrigues the losses are even greater. No contiguous areas of native forest are left, only 3 species of the 17 original vertebrate species remain, and 35 of the remaining 37 endemic plant species are endangered.

These dramatic statistics are a consequence of a range of anthropogenic factors, which have acted on the islands since their colonisation just 400 years ago. This section details those processes and impacts.

1.2.1 Habitat Destruction

Habitat destruction, chiefly for agriculture and settlement has been very rapid on both Mauritius and Rodrigues. Agriculture is very intensive with 45% of Mauritian land under cultivation, and with nearly 1.2 million people Mauritius is one of the world's most densely populated countries. Major clearance of forests on Mauritius ceased in the 1970s after the end of a large-scale scheme to replace native forest with pine plantation forestry. Clearance of land in Rodrigues was mainly for agriculture, which at one time or another was attempted on practically all areas of

Figure 1.c. Rodrigues - Sites of major biodiversity importance referred to in the text.

the island including the major watersheds (Gade 1985). Reafforestation of watersheds has been implemented in Rodrigues over the past 30 years using alien forestry plantation species, many of which are invasive or water-demanding species.

On Mauritius, the remaining native forests are highly fragmented. The majority of remnant patches are situated in the uplands of the south-west of the island, in the 6,574 ha. Black River Gorges National Park. Smaller remnants of high biodiversity importance are found in the southeast and the northern mountain ranges. In addition, there are a few other forest patches which are important for particular rare plants and animals; only a few of these areas are in managed nature reserves. All of the non-managed areas of native forest on Mauritius are invaded to some extent by alien invasive woody weeds.

The situation is even more extreme on Rodrigues, where there is no surviving contiguous native forest canopy at all. Patches of endangered plant species are scattered across the island. The Mourouk Valley has the largest concentration of native plant vegetation and diversity. Grande Montagne nature reserve contains a number of specimens of key Critically Endangered plant species. Anse Quitor nature reserve contains a range of lowland Critically Endangered plant species not represented in Mourouk or Grande Montagne. Although they contain some of the 'best' remaining native vegetation of Rodrigues, all three areas are dominated by alien invasive woody weeds.

A significant amount of native biodiversity still remains on the small islets off Mauritius and Rodrigues. By virtue of lack of settlement, and in many cases relatively limited introductions of invasive alien species, these areas have been spared some of the worst destruction that has affected equivalent areas on the mainland. Round Island, a 169 ha islet about 20 km from the northern coast of Mauritius contains at least four (possibly five) species of reptile found nowhere else on earth. These species were spared extinction because rats have never colonised the island (Bullock 1986). Round Island also contains the last remnants of the palm-rich forest that once clothed much of northern Mauritius. Ile aux Aigrettes, a 26ha islet less than one kilometre from the southwest coast of Mauritius, contains the best remaining remnant of coastal ebony forest that used to surround much of the main island. Like the mainland forest remnants, all of the non-managed offshore islets are highly invaded by alien invasive weeds. Round Island is the only islet that has escaped invasion by woody weed species.

1.2.2 Direct Exploitation

Direct exploitation of certain species has pushed them towards extinction. Mauritius was originally settled for its hardwood timber, which was highly prized. Many of the species that were exploited are now extremely rare. All of the Mauritian palm species were probably exploited for their edible hearts and all are now threatened (Maunder et al. 2002). The five endemic species of Mascarene giant tortoises (two species each on Mauritius and Rodrigues and one species on La Réunion) are all now extinct having been massively exploited for their highly palatable meat (Cheke 1987). Direct exploitation of most species has now largely ceased although certain plant species are still being taken from the wild in large quantities for medicinal purposes, notably in Rodrigues, and endemic reptiles have been illegally caught for the international pet trade.

1.2.3 Invasive Alien Species

At least 21 introduced species of mammal, reptile and mollusc are naturalised in Mauritius, with assumed detrimental effects on native flora, while 18 plant species have been identified as particularly aggressive invaders in Mauritius (Strahm 1999). Animals such as Javan deer *Cervus timorensis*, introduced to Mauritius in 1639, browse native seedlings and spread alien seed. Feral pigs *Sus scrofa*, introduced in 1606, disturb the soil and spread alien seed. Egg predation by pigs was also probably partly responsible for the extinction of several endemic species that nested on the ground, notably the dodo *Raphus cucullatus* and two species of giant tortoise *Cylindrapsis inepta* and *Cylindrapsis triserrata*. Feral pigs also probably adversely affect ground-dwelling invertebrates. Javanese macaques *Macaca fascicularis*, introduced at the turn of the seventeenth century, damage native fruits before maturation and predate on eggs and chicks of native birds. Rats *Rattus rattus* and *Rattus norvegicus*, possibly introduced prior to first settlement, predate on eggs and chicks of native birds (Safford & Jones 1998). Both rat species also predate on invertebrates and are notable seed predators (Cuddihy and Stone 1990).

As highlighted in section 1.2.1, all of the vegetation zones of Mauritius and Rodrigues, apart from those areas that are undergoing restoration,

are highly invaded by alien invasive weeds. The dominance of invasive weeds is rapidly increasing in all areas that are not managed. This degradation is caused by a diverse suite of alien weed species. Their impacts can be illustrated by the examples of Chinese guava *Psidium cattleianum* and privet *Ligustrum robustum,* two of the dominant invasive plant species in the upland forests. *Psidium* first noted as being present in Mauritius in 1763 (Rouillard and Guého 2000), is spread by native and exotic birds as well as by invasive mammals such as wild pigs and macaques (Strahm 1999). *Ligustrum*, first cultivated in plantations in 1902 (Rouillard and Guého 2000), is spread by native and alien bird species. Both Chinese guava and privet are capable of establishing under deep shade and have relatively rapid growth rates, high fruit establishment and long fruiting seasons (Smith 1985 and Lavergne et al. 1999). All non-managed areas of native upland forest on Mauritius are highly invaded by Chinese guava and privet. A recent quantitative survey of ten 50 x 20 m plots of native Mauritian upland forest, first surveyed 60 years before, has shown that only 29% of native trees and shrubs remained after the 60 year period (Motala 1999). These losses included many large mature trees. This is clear evidence that the upland native forest is very rapidly being strangled by the alien weed invasion.

2. Terrestrial Conservation methods and achievements in Mauritius & Rodrigues

The wide range of activities that make up the conservation programme in Mauritius and Rodrigues can be divided into distinct categories:

- Species recovery programmes
- Weeded and fenced conservation management areas
- Active restoration of degraded areas by weeding and planting
- Islet restoration

This section reviews the methods used in each category of action in the Mauritian context, and the resulting conservation achievements to date.

2.1 Species Recovery Programmes

In recent years Mauritius has had the dubious distinction of being home to the worlds most endangered raptor, pigeon and parrot; the Mauritius kestrel *Falco punctatus*, down to a single known pair in 1973, the pink pigeon *Columba mayeri,* down to 10 known birds in the wild in 1990, and the echo parakeet *Psittacula eques echo,* down to 12 known birds in the wild in 1986. Concerted conservation work in Mauritius began with the species recovery programme for the Mauritius kestrel in the early 1970s (Jones and Hartley 1995) along with preliminary conservation work on the pink pigeon and echo parakeet. Rare plant species recovery work began in the early 1980s.

The rationale behind each species recovery programme is that as much effort as is practically possible must be made to enhance the survival success of each individual of the endangered species in question. There are several reasons behind this.

- These species are very rare so every individual is precious.
- Each individual (at least in the founder population) must have the chance to reproduce to maximise the genetic variability in the recovered populations.
- The chances of emerging from a genetic bottleneck with the maintenance of a high degree of population heterozygosity is maximised if the numbers can be rapidly increased (Frankel and Soulé 1981).
- The threats that made the species endangered in the first place are probably still be present and therefore any recovery programme is unlikely to succeed if these threats are not managed.

2.1.1 Species recovery management methods

Management techniques used in Mauritius for bird conservation focus on intensive management of wild populations backed up by captive rearing and releases. These techniques include: harvesting wild eggs to encourage extra production in the wild and for captive rearing, fostering of chicks to wild or captive pairs without offspring (or in captivity to related bird species where appropriate), predator control around nests and in feeding areas, provision of artificial nest boxes, supplementary feeding of released birds, and veterinary intervention where necessary. The use of these methods in Mauritian bird species conservation has been documented in detail elsewhere (e.g. Jones and Duffy 1993).

The plant species recovery programmes in Mauritius and Rodrigues include population surveys and intensive efforts to propagate rare plant species from seed or vegetatively. Trials are undertaken in order to optimise growing conditions. Amongst the factors that have been investigated in order to optimise propagation are: media used, seed treatment, pest management in

the nursery, and planting practices. Plants are not necessarily planted in the area of origin of the parent stock, as it may be very difficult to manage the threats to the plant in these locations. Therefore many plants are reintroduced to appropriate locations in managed nature reserves, Conservation Management Areas (Section 2.2.) and intensively managed islets. In recent years there has been an increasing emphasis on after-care of those plants that have been reintroduced.

2.1.2 Species recovery achievements

Intensive management has helped the kestrel to reach a population of over 600 birds at the time of writing; as this is a healthy population size for an island raptor the Mauritius kestrel is now considered to have been saved from extinction (Jones, pers. comm.). The pink pigeon and echo parakeet currently have wild populations of between 350 to 450 and between 150 and 170 birds respectively and are on their way to safety, although both populations still require intensive management. Part of this management has been habitat manipulation such as area-wide predator control. The potential for self-sustaining pink pigeon and echo parakeet populations in the long term is limited by the lack of available habitat (unlike the Mauritius kestrel which has adapted well to secondary forest). Therefore, integration of species recovery with ecosystem restoration programmes will be critical to the long-term success of these species recovery programmes.

The intensification of plant species recovery efforts in Mauritius and Rodrigues in recent years has resulted in the production of large numbers of endangered plants. From 1998-2001 70,000 individuals of 39 species of endangered plants have been propagated on Rodrigues, 17,000 individuals of 21 species of endangered plants on Ile aux Aigrettes. Nearly 9,000 individuals of 48 species of endangered plants have been propagated on the Mauritius mainland over the 10 years to the end of 2000. All of these specimens have been reintroduced into appropriate areas of managed native forest.

2.2 Weeded and Fenced 'Conservation Management Areas' (CMAs)

The concept of small managed areas for the protection of endangered forest types and Critically Endangered plant species was spearheaded in the late 1930s by Vaughan and Wiehe. These authors surveyed ten 50 x 20 m plots in the Macabé forest in the south-western uplands of Mauritius (1941). One of the ten plots was earmarked as an intensive study plot ('Vaughan's plot'). The authors recommended that this plot was weeded of all alien species and fenced to keep out introduced deer and pigs. The plot was weeded sporadically from the late 1930s but was not fenced until 1986. In 1986 Strahm and Dulloo resurveyed the woody plants in this plot (Strahm 1994). In spite of the inconsistent management Vaughan's plot was considerably more diverse in 1986 than an adjacent non-managed plot.

The results of the surveys at Macabé inspired the setting up of a series of weeded and fenced Conservation management Areas (CMAs) in different parts of the upland forest that were representative of the different ecotypes identified by Vaughan and Wiehe in 1937. Overall management of the CMAs in the National Park is by the Mauritian Government's National Parks & Conservation Service (NPCS) with the Mauritian Wildlife Foundation (MWF) in a consultative capacity. MWF also manages individual projects within the National Parks and the CMAs. The CMAs outside the park are managed by a variety of public and private agencies.

2.2.1 CMA restoration and management methods

In spite of the fact that the CMA sites are chosen for their relatively high proportion of native canopy cover, amongst other criteria, initial weeding is still a labour-intensive task. The first step of initial weeding is to hand-weed all of the relatively easily removed alien seedlings, saplings and herbaceous vegetation. This is followed by the cutting of woody stumps (which are mostly of Chinese guava and privet) with a machete and manually uprooting the stumps with the aid of hand tools. Cut stump treatments using herbicides have been used sporadically in the past but with little consistent documentation of the methods or monitoring of efficacy. A trial of initial weeding using herbicide treatments is currently ongoing (Mauremootoo and Florens unpublished data). Occasionally individuals of some non-native species have been left or allowed to regenerate in areas that are highly degraded. These are then slowly removed as native species establish themselves.

The number of man-hours that it takes to initially manually weed an area varies with biotic factors such as initial forest quality, site substrate and

alien species composition as well as logistical considerations such as remoteness of the site and degree of motivation of the labour team. Time-motion studies have estimated initial weeding to vary from between 315 and 890 man-hours per ha, costing an estimated $US9,000 per ha on average (all costs, in US dollars are given are at 2001 prices and exchange rates).

The CMAs are fenced using 2 m high chain link fencing of 7.5 mm mesh size, topped with barbed wire to a varying height to keep out passers-by. Posts are 3 m apart and of 11.5 cm thick treated wooden poles. In most instances the base of the fence on the outer side is covered with small rocks to prevent pigs from burrowing into the fenced area. The total fence cost is ca. $70 per running metre.

Until recently each weeded area has been 'maintenance' weeded four times per year. The annual budget for maintenance weeding of the 38 hectares of weeded CMA under the management of the National Parks and Conservation Service (NPCS) is $74, 000. Since 1999 the frequency of maintenance weeding has been reduced to three times per year.

Control of predators is carried out in CMAs where intensive management of native birds, in particular pink pigeons and echo parakeets is being undertaken i.e. Brise Fer, Mare Longue and Fixon (Roy 2001). Cats and mongooses have been systematically controlled in these areas since the early 1990's. They are live trapped throughout the year in an intensive grid and along access points. Rats have been controlled sporadically in some CMAs since 1992, mainly using the anti-coagulant Brodifacoum.

2.2.2 Conservation Management Area achievements

Currently eight weeded & fenced CMAs, covering an area of ca. 40 ha, have been created in the Black River Gorges National Park. Three plots covering an area of approximately 17 ha are being managed in a similar way outside the park (Table 2).

Table 2. Fenced and weeded Conservation Management Areas in Mauritius created from 1969-2002

Name	Size (ha.)	Date first weeded
CMAs in the National Park		
Bellouget	2.5	1994
Brise Fer	24	1986-87
Fixon	4.3	1994
Florin	2.53	1995
Pétrin	6.2	1994
Macabé	0.4	1986
Mare Longue	3.46	1993
Montagne Cocotte	0.338	1987
CMAs outside the National Park		
Mondrain	5	1979
Perrier	1.44	1969

In order to gauge the effectiveness of CMA management several studies have been undertaken to assess the densities of key taxa inside CMAs and in comparable adjacent non-managed areas. These include studies on the following taxa: native tree and shrub saplings (Eydatoulah 1999), native butterflies (Mauremootoo unpublished data), native and non-native land snails (Florens 1996) and native passerines (Hill unpublished data and Ali Boyla 2000). No studies were carried out on the effects of CMA management on pink pigeons and echo parakeets, as any effects would be compounded by the fact that these birds are being released and fed in these areas. However, it has been observed that pigeons increase the use of these sites immediately after initial weeding (Jones, pers. comm.). The effect of CMA management on kestrels has not been assessed because of methodological difficulties.

The results of the above CMA studies can be summarised as follows:

- Consistent weeding and maintenance of fences appears to result in a high level regeneration of native flora. In the Brise Fer 'Old Plot', first weeded and fenced in 1987, a minimum of between 53% and 68% of native tree taxa are regenerating compared with between 32 % and 40 % in an equivalent non-managed area. Differences for numbers of individuals regenerating are even greater with 4.5 times more individuals in managed than in non-managed area. It is likely that the numbers of species regenerating would have been higher if this plot were larger due to species areas effects. However, some species would be unlikely

to regenerate even in a larger plot possibly because of the action of mammals that cannot be excluded by conventional fences.
- The diversity of native seedlings and saplings is relatively low in a more recently managed part of Brise Fer and in the nearby Mare Longue CMA respectively. In the former this may be due to the fact that several deer were fenced into the CMA for over two years. In the latter, rocks were not placed at the foot of the fence, thus allowing pigs to burrow into the plot.
- Native butterflies were on average nineteen times more abundant in the surveyed CMAs than in non-managed areas. Species composition varied between different CMAs in relation to canopy cover, which is well correlated with years since initial weeding.
- The results for native birds were equivocal. It is clear that very degraded forest areas were poor for native birds but one group (the Not Threatened endemic grey white eye *Zosterops borbonica*) was found in higher numbers in non-managed areas with the equivalent native canopy.
- The densities of some native snail groups were lower in the Old Plot than in an equivalent non-managed area. This may be due to the effect of persistent rat poisoning and the change in habitat after initial weeding.

These summaries therefore show that the current CMA methodology can be highly effective if the fencing is maintained to a consistently suitable standard, and if any incursions of deer and pigs are dealt with rapidly. They also show that weeding methods may have to be modified to minimise non-target damage. For example, weeding could be carried out in relatively small patches, in contrast to current practices of weeding contiguous areas systematically. This could provide relatively sessile organisms, potentially negatively impacted by initial weeding, with refugia from which to recolonise weeded areas as native vegetation regenerates. In addition, non-regenerating or negatively impacted species may have to be managed individually. Finally, as rat and monkey predation of eggs, chicks, fruits and seeds are likely to be major limiting factors in the recovery of more sensitive bird and plant species, it may be cost effective to complement or replace current CMAs with areas protected by predator-exclusion fences. Predator-exclusion fences are successfully and increasingly being used in analogous situations in New Zealand and Australia, and a pilot testing of this technology is just about to start in Mauritius.

2.3 Restoration of Extremely Degraded Areas by Intensive Weeding and Planting

In some cases even intensive weeding and fencing will not be enough to secure the ecosystem restoration goals we have set ourselves. Some of our restoration sites have become so degraded that weeding alone may simply provide the conditions for the huge weed seedbed to germinate and rapidly choke the area with weeds once again. In addition there are likely to be very few native species in the seedbank to compete with the weeds. In these cases we will weed (either partially or completely depending on factors such as slope and shade requirements of the plants we are planting) and plant native pioneer plants in order to colonise the site. At first hearing it seems strange that we would chose a restoration site that is almost completely invaded. The sites are chosen because they contain some very endangered plant and animal species (e.g. Grande Montagne), because they form a part of an otherwise fairly well conserved ecosystem (e.g. the areas of Ile aux Aigrettes close to the ebony forest zone) or because the area is part of a small island which, in the long term may be restored to an almost completely native cover with minimum reinvasion from alien seed sources (e.g. Round Island).

2.3.1 Methods used in active restoration of extremely degraded areas

Initial weeding of extremely degraded areas is very intensive. The following figures from Ile aux Aigrettes are typical of the sites being restored in Mauritius and Rodrigues. Initial weeding (mainly by hand) of degraded areas takes about 1920 man-hours per hectare. This translates into a cost of approximately $3,000 per hectare. These weeded areas are then planted with nursery-grown native pioneer species. The initial heavy weeding must soon be followed up by intensive light weeding because the sudden increase in light levels in the newly weeded areas results in a rapid germination of the very large weed soil seed bank. Such high intensity maintenance weeding may take another 1920 man-hours per hectare in the first year of management. The effort then diminishes exponentially in subsequent years as the weed soil seedbank is exhausted and planted native species grow, thus decreasing light levels on the ground and increasing competition with regenerating weeds. Once a good canopy is established (within 4-10 years following initial weeding) the area

needs to be weeded only once every five years (ca. 440 man-hours per hectare or 88 hours per ha. per year). This translates into a long-term maintenance cost of ca. $140 per ha.

2.3.2 Achievements in active restoration of extremely degraded areas

The focus of active restoration of extremely degraded areas has been in the two original nature reserves of Rodrigues (Grande Montagne and Anse Quitor) and on Ile aux Aigrettes (an offshore islet of Mauritius). Intensive restoration of extremely degraded areas of Round Island has been started very recently (mid 2002).

From 1998 – 2002 around 15 ha of degraded forest has been restored in the two nature reserves on Rodrigues. The plants have grown faster than anticipated with some species capable of putting on over a metre of growth in height in a year. Survivorship levels have also been high with many species showing over 80% survival. The restored upland plot at Grande Montagne is now beginning to attract rare endemic birds which are using the newly planted trees as nest sites.

Plate 1. Restoration of degraded forest in Rodrigues: Photopoints - Grande Montagne Rodrigues

From 2000 – 2002 around 7 ha of degraded forest has been actively restored on Ile aux Aigrettes. Growth and survival rates of the introduced plants have been similar to those on Grande Montagne. The restored areas are beginning to attract the reintroduced pink pigeon.

2.4 Islet Restoration

In theory most of the islets that surround Mauritius and Rodrigues could be restored given the relative ease with which mammals such as rats and cats can be eradicated and reinvasion minimised and our increasing abilities to grow and plant out native plants. However resources are always limited so the management of Mauritian islets has been prioritised based on each islet's intrinsic conservation value, ease of restoration and competing priorities of other sectors. The following categories have been chosen (Bell et al. 1994):

- Strict nature reserves: Islets with high endemism and relatively few invasive species problems e.g. Round Island.
- Open nature reserves: Islets with Conservation potential that can be used for controlled tourism. Already with a lot of invasives present e.g. Ile aux Aigrettes.
- Tourism and recreational islets: Those that are highly degraded but have important leisure and tourism value and long term potential for restoration
- Passive reserves: The remaining islands on which any developments must be carefully considered so that their (current and potential) values are maintained.

2.4.1 Islet restoration methods

Once an island has been chosen for restoration management, the first step has been to legally ensuring there are no inappropriate development projects, next to eradicate introduced vertebrates as far as is possible, and then to manage its vegetation through a mixture of CMA-type management and active restoration (as outlined in section 2.3.1). Once the restoration process is started, the establishment and maintenance of good quarantine controls is essential, and must continue indefinitely. This is necessary to prevent reinvasion of the mammal species that have been eradicated

or never have reached the island and to keep out plant species, many of which would be difficult or practically impossible to eradicate from even the smallest of islands.

2.4.2 Islet restoration Achievements

Rabbits and goats have been eradicated from Round Island, rats and cats were eradicated from Ile aux Aigrettes, hares have been eradicated from Gunners Coin and mice have been eradicated from Ile aux Cocos (Rodrigues).

Pilot restoration activities on Round Island were carried out periodically from the early 1980s to mid 2002. All major weeding and planting were planned for completion on Ile aux Aigrettes by 2003; major acceleration of the intensive restoration of Round Island vegetation started in mid 2002.

Rats have also been eradicated from other islets of high conservation potential; restoration of these islets will be possible given additional funding, time, enhanced techniques and avoidance of inappropriate development projects.

3. The Next Step: The Challenge of Large Scale Restoration?

After about 25 years of hands-on conservation in Mauritius we can summarise some of our major achievements as follows:

- We have saved many of our most endangered species from the brink of extinction
- We can probably save most of our remaining endangered species from the brink of extinction, given sufficient resources
- We can restore Mauritian forest ecosystems to something approaching their former state in a relatively short period of time period through intensive restoration programmes
- We can propagate most of the endangered plant species of Mauritius and Rodrigues
- Conservation capacity in Mauritius has increased hugely in recent years
- Mauritius has provided examples of successful conservation efforts which have inspired others in similar 'desperate' circumstances to believe that success is possible.

These conservation achievements are already very impressive, however we are still only working to conserve a very small proportion of the areas that have restoration potential. Currently we are actively restoring only 18% of the area of islets that have high restoration potential, and only 2% of mainland areas that have high restoration potential. In the meantime, 'good quality' native forest that is not being managed is very rapidly degrading (Motala 1999).

It could be argued that the Mauritian conservation effort should stick with the tried and tested techniques, continuing to intensively manage individual species and small areas, and not try to over-stretch itself by scaling up the effort. We agree that we must consolidate our gains. However, it is clear, from the combined evidence of the limitations of our current achievements, that we can only create truly viable populations of our endangered plant and animal species if we scale up our existing efforts. There are several reasons why this is imperative:

Lack of habitat for many endangered species: Taking the example of the Critically Endangered echo parakeet population, this species is already apparently food limited and its numbers are a long way below its minimum viable population. The echo parakeet is also limited in terms of nesting sites, because it nests in cavities in large native emergent trees which are dying rapidly due to unmanaged weed competition (although this might possibly be rectified by the provision of artificial nest boxes). Pink pigeons, known to favour native foliage, flowers and fruit are also probably food limited and are currently dependent on supplementary feeding. Good regeneration levels for many native tree species are occurring in the best managed CMAs but most species are only regenerating in very low numbers because of an absolute lack of suitable areas. Without very significant expansion of the area of managed upland forest, it is likely that much diversity and many species will be lost in the long-term through processes such as genetic drift and stochastic factors (notably cyclone impacts).

Likelihood of extinction of the many species for which individual species recovery programmes are not practical: We are well aware that the situation is critical for our endangered birds and for many of our endangered plant species. It is also extremely likely that the loss of habitats for these species is resulting in an unseen but equally dramatic loss in the diversity of less charismatic biota such as native invertebrates, lower plants and fungi.

Viability of managed areas is likely to be positively related to fragment size: The smaller CMAs such

as Macabé are proving very difficult to maintain, as the weed reinvasion rates are so rapid. Cyclone impacts are also increasing because the forests surrounding CMAs are degrading to a low stature Chinese guava dominated thicket, with the result that the taller vegetation within CMAs is decreasingly buffered against cyclones. In addition such plots provide limited parent material, a problem exacerbated by the degradation of the surrounding non-managed area.

Even if it is agreed that the scaling up of forest restoration is a desirable goal, it could be argued that this aim is unrealistic given the fact that current approaches to restoration are so labour intensive. The tacit assumption behind advocating an increasing in the scale of restoration operations must therefore be that we can either reduce costs or raise additional financing. This could be achieved through: (1) Reducing the unit cost of restoration activities; primarily through minimising the cost of weed management. (2) Additional government investment in conservation. (3) Development of alternative financing mechanisms for some components of restoration. Several approaches to this problem, all of which need urgent investigation, are outlined below.

3.1.1 Fine tuning existing techniques

It is clear that we can improve current practices. Initial weeding costs, for example, can be halved by replacing labour intensive uprooting with paintbrush herbicide application to cut stumps. Observations indicate that it is not necessary to weed CMAs nearly so frequently as is currently the case following the initial need to reduce the high residual levels of alien weed seed in the soil seed bank. Maintenance weeding can also be rationalised by concentrating on removal of species that represent a threat to native species regeneration, rather than removing every non-native plant to produce a 'clean' plot. It may also be possible to save on fencing costs in the upland forests by conducting park-wide deer and pig control, probably at zero cost (e.g. by granting concessions for responsible hunting). By integrating these measures it would be possible to considerably increase the area of managed CMAs within the current budget. However, even if this fine-tuning resulted in a five-fold increase in the managed area, the total area of conserved forest would still be relatively small.

3.1.2 The use of fire

Fire has been widely used as a weed management tool around the world (Hardy and Arno 1996). In some ecosystems burning is a way of stimulating the regeneration of native species. This is not the case for Mauritian ecosystems, which show no signs of being adapted to fire. Therefore it is not feasible to use fire in areas that already have a good cover of native vegetation. However, in areas that are almost completely covered with alien weeds a controlled burn may be the most efficient way of initially reducing this weed infestation. The use of fire could therefore significantly reduce the costs of active restoration of extremely degraded areas.

3.1.3 The use of grazers

The Mauritian ecosystem has lost many of its key components in the 400 years since man's colonisation (Cheke 1987). This includes the giant tortoises that once roamed the Mauritian landscape in enormous herds. These animals must have had a huge influence on the ecology of pristine Mauritius and may have been keystone grazers and seed dispersers. Because the tortoise densities were so large, plants would have been under strong selection pressure to defend themselves against tortoise herbivory. It has been proposed that heteroblasty (markedly different leaf forms of the foliage on the same individual plant depending on the height of the foliage from the ground), which is very pronounced in many Mauritian and Rodriguan plants, is an evolutionary response to tortoise herbivory (Eskildsen 2000). Furthermore, anecdotal evidence suggests that Mauritian native plants species are very tolerant of trampling.

Unfortunately the two Mauritian species of giant tortoise are now extinct. However there is a possibility of using an alien but closely related extant species, the Aldabran giant tortoise *Geochelone gigantea*, as a functional analogue for the extinct Mauritian giant tortoise species.

Aldabran giant tortoises were introduced to Ile aux Aigrettes in late 2000 to experimentally investigate their role in vegetation management and in seed dispersal. It is still too early to make definitive conclusions, but preliminary findings are as follows. Tortoises do seem to have the potential to maintain weed populations at low levels but they cannot suppress large existing tall woody weed populations in the short term. Tortoises are also effective seed dispersers of both native and alien species. Therefore, it appears that tortoises might be very effective restoration tools once weed levels are initially suppressed. Nevertheless, potential

negative impacts on native species, and rarer species in particular have not yet been ruled out, so final conclusions on suitability of this method cannot yet be made.

Even if grazing by giant tortoises does prove to be a safe and effective conservation management tool, in practical terms it would be several decades before tortoises would be available in the quantities required to play a significant role. They may also be relatively less effective in the cooler and wetter uplands than in lowland areas such as Ile aux Aigrettes. Nevertheless they may be critical weapons in our restoration arsenal in the long term. They could be used seasonally in upland areas simulating a possible annual movement that may have occurred in pristine Mauritius (V. Florens, pers. comm.). In the meantime an alternative possibility is to use mammalian exotic grazers (e.g. sheep) as part of a managed programme to scale up ecosystem restoration to larger areas.

3.1.4 Integration of cost-reducing restoration methods

The most likely design for large-scale ecosystem restoration programmes for Mauritius and Rodrigues would be an integration of cost-reducing tools with current methods. Below we give a hypothetical generic scheme for an integrated large-scale restoration approach in the Mauritian context:

1) Initial weeding of a degraded area using an integrated approach (area-specific combinations of manual and mechanical weeding, use of herbicides, use of fire and use of grazers and browsers).
2) Regular monitoring of the level of weed species in the soil seed bank from the completion of the initial weeding.
3) Sowing of non-invasive pasture grasses into weeded area to suppress weed resurgence.
4) Stock fencing of managed area to prevent access of domestic stock to zones under long-term conservation management or to degraded zones not yet under a management programme.
5) Release of pre-determined densities of domestic stock into the managed area to control the level of weed resurgence from the soil seed bank.
6) Removal of domestic stock when the weed seed bank has reached very low levels.
7) Managed area left to regenerate from native parent trees in the vicinity or planted with native 'framework' species depending on the prevailing densities of parent plants in the area.
8) Selective low frequency manual weed control continued as necessary.
9) Option to periodically introduce livestock into the area if they prove to be relatively selective to the benefit of native species.
10) Long-term option of introducing tortoises as a permanent or seasonal feature of the area to aid in weed management and native seed dispersal.

3.1.5 Mainstreaming our restoration activities

Even if all of our restoration activities are operating at their optimum efficiency they are likely to cost more than they do at the moment if operations are scaled up. The ultimate key to raising the sums of money needed to undertake these efforts will be to incorporate biodiversity conservation into mainstream concerns. The benefits of this would be both in terms of cost recovery and in making conservation activities more central to peoples' lives. Below we give a range of financing ideas, including some currently adopted initiatives:

Exploitation of woody material produced following initial weeding: Initial weeding usually results in the production of a large quantity of organic material, which is either left to rot or is burned. In both cases a potential resource is not being exploited. The wood could be chipped and used as mulch, which will aid native saplings (either planted or naturally regenerating) and help to suppress weeds. Waste wood may also be a potential feedstock for biomass fuel production. A limitation of these approaches is the need to get a chipper close to the weeded area. A trailer version can be used for many areas of the forest but not those that are too far away from good quality tracks.

Taxation on forest products: This is currently being undertaken for one form of forest exploitation, the export of introduced monkeys from Mauritius for biomedical research. Currently about 8,000 wild caught and captive-bred monkeys are exported each year from Mauritius. A levy of $50 per monkey is paid into the (National Parks and) Conservation Fund. This fund is used to pay for activities relating to the conservation of Mauritian and Rodriguan native biodiversity.

Leasing of grazing rights in restoration areas: We have already mentioned grazing as a means to extensify restoration. Leasing of grazing rights could also provide income to partly cover costs. This approach is becoming more and more widespread in restoration schemes throughout the

world.

Leasing of hunting rights for park-wide predator control: Many of the mammal species that if unregulated have the potential to damage our native wildlife, are valued game species. Regular culls may be self-financing to some extent if the hunting rights are leased out. Mauritius has a strong hunting constituency, which would probably be very supportive of such initiatives

Ecotourism: Mauritius receives about 600,000 (mostly affluent) tourists every year many of whom would be interested in contributing to the protection of the country's natural heritage, if this concept was marketed in the right way. For perfectly valid reasons most visitors do not know of our greatest terrestrial biodiversity treasures. Round Island is rightly kept as a restricted access nature reserve because of the treacherousness and fragility of its terrain and the vulnerability of its biota to invasive alien species. Many of the best areas for seeing our endemic birds are also restricted access because of our intensive management activities. Only the island nature reserve of Ile aux Aigrettes is geared up for conservation and ecotourism. Well designed attractions on the mainland for example conservation management areas specifically for ecotourism with features such as clear interpretation, canopy walks and animal viewing hides could not only provide sustainable income for conservation but also serve as a powerful awareness-raising tool.

'Environmental' taxes on tourism: This approach has been pioneered by Ecuador as one means of financing the conservation of the Galapagos Islands. The Government of Mauritius has implemented such an approach to raise funds for environmental protection in general by establishing an Environmental Protection Fee within the tourism industry (a 0.75% levy on all hotel turnover). These funds are invested in a Government trust fund, the National Environment Fund, which is managed by the Ministry of Environment. It is possible that some of these funds could be made available for large-scale restoration in future.

Ecosystem services: It seems very likely that native forest can provide important ecosystem services such as watershed protection. To some extent this function appears to be adequately provided by secondary forest in Mauritius. However, this does not seem to be the case in Rodrigues, which is relatively dry compared to Mauritius and where much of the exotic forest that clothes the watersheds is of water-greedy trees such as *Eucalyptus*. As it is almost universally acknowledged that chronic water shortages are Rodrigues' number one problem a great opportunity exists to implement a watershed rehabilitation scheme of the type pioneered by the 'Working for Water' (WfW) programme in South Africa in Rodrigues. By focusing a scheme for the removal of alien plants on the provision of water, the South African scheme has managed to tap into funding sources that would not be available for biodiversity conservation alone.

Employment generation: Even at their optimum efficiency ecosystem restoration activities will remain labour-intensive. WfW heavily emphasises its socio-economic value as a generator of meaningful employment. Again in Rodrigues, there is a great opportunity to provide employment in an area where there is widespread un-employment and under-employment. An opportunity for linking forest conservation and meaningful employment to prevention of another conservation threat is the system of bad weather payments in Rodrigues. This is a government-funded stipend paid to all registered fisher people each day that fishing is not possible due to bad weather. The result is that the Rodrigues lagoon is severely over-fished and damaged, notably by 'piqueses d'ourite' fisher women who walk out to and onto the reef to spear octopus. Many of these women admit that they make negligible income from the fish that they catch, and that they register as fisher people in order to get the bad weather payments. The government could thus help solve two biodiversity conservation problems by rechannelling the funds for bad-weather payments into paying these effectively unemployed people to provide labour for forest restoration.

The use of volunteers: Current conservation projects in Mauritius would not be as successful as they have been if it were not for the input of volunteers, some of whom possess a high level of skill. MWF uses volunteers to some extent in most of its projects. A great deal of the labour used in the field in the pink pigeon species recovery project is provided by (mainly expatriate) volunteers. Volunteers have undertaken a little over half of the work undertaken for the restoration of Grande Montagne Rodrigues. In this case the volunteers are mostly Rodriguan, a

phenomenon that owes much to the Rodriguan management of the project on the ground and the existence of an active community education project that brings the conservation message to all Rodriguans. With increasing local management of projects and community outreach projects such as that pioneered in Rodrigues becoming adopted in Mauritius, it is likely that the contribution of volunteers to restoration efforts will increase.

Even if the above list is far from exhaustive, it does indicate that an integrated approach to the financing of restoration activities coupled to a similar approach on the technical side gives us the chance to be part of a very exciting future in ecosystem restoration in Mauritius and Rodrigues. We are convinced that the conservation community in Mauritius and Rodrigues can restore large areas of indigenous forest sustainably by harnessing the same creativity and energy that have been responsible for the conservation and economic-development successes in our country to date.

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