Restoration of highly degraded and threatened native forest in Mauritius

MAR/93/G31

FINAL EVALUATION

26 April - 8 May 1999

Simon V. Fowler
Landcare Research
Private Bag 92170
Mt Albert
Auckland
New Zealand

Contents

I. Executive Summary

To add

II. Project Concept and Design

A. Concept

DRAFT – part extracted from original project proposal:

Mauritius is a small (1865 km^2) tropical island in the south of the Indian Ocean, and together with La Réunion and Rodgrigues islands, forms the Mascarene group of islands. Mauritius is located at latitude 20° South and longitude 58° East, some 800 km from Madagascar. This isolation is has been crucial to the development of the unique biodiversity of Mauritius and the other Mascarene islands. Despite its small size, Mauritius has a human population of over 1.1 million, concentrated in an urban axis running south east from Port Louis to Curepipe, and growing at 1.3% per annum. The population includes a wide variety of ethnic groups including Indo-Mauritians, creoles of African origin, Sino-Mauritians and Europeans. The standards of health, nutrition and education are high compared to other countries in Africa. The adult literacy rate is 83% and the life expectancy at birth is about 66 for males and 73 for females.

Mauritius has a tropical maritime climate, generally dominated by the SE trade winds, with a warm, moist summer from December to May and a cool, dry winter from June to November. Mauritius was formed by volcanic activity, starting 8-9 million years ago. In isolation, the island has evolved a unique flora and flora with a high proportion of endemic species found nowhere else. Typical of isolated islands, the fauna and flora are 'disharmonic', that is they are dominated by particular groups while other groups are absent. The most obvious example of this is the lack of any native terrestrial mammals apart from bats. As a result, birds and reptiles such as skinks partly filled many of the niches typically occupied by terrestrial mammals on continental areas. Some of the most serious invasive species on islands, such as terrestrial mammalian grazers and predators, have a particularly large impact because the fauna and flora is not adapted to these types of organisms.

550 people per square km
(rise to 700 by 2020 – FAO)
90% of land privately owned
48% under agric (57% of this sugarcane)
31% under forest, woodland or scrub – but only 1.27% native (mostly in the Black River Gorges National Park)
But deforestation has been zero since early 1990's

Table 1. Numbers of species in several prominent taxa that are native, endemic and threatened with extinction in Mauritius (including Rodrigues). Source : UNEP/COI

	Mammals	Birds	Higher Plants	Reptiles
All native species	4	27	700	11
Endemic species	2	9	325	8
Threatened species	4	10	222	6

IUCN rate Mauritius as the island with the third most threatened indigenous biodiversity (after Hawaii and the Canary Islands). ??2nd after Hawaii in terms of no. Endemics??

... global significance of Mauritian biodiversity
... extreme threat - circumstances created by habitat loss (mostly ameliorated now??) but continued by the presence of invasive alien species, particularly vertebrates and higher plants (but note lack of knowledge of significance of other invasive taxa e.g. arthropods, micro-organisms).

History of the creation of protected areas – and NP in 19xx
(Note significance of areas outside??)

History of the pioneering work on the creation of protected and studied vegetation plots in the upland forest, starting with Vaughan ( ), and continuing with Strahm etc to present.

Parallel concept of mainland islands in New Zealand
(Carl's point about NZ work coming from the island perspective and the plots starting from a small scale perceived need to protect even tiny areas ... restricted in size by available resources and technology)

Bring all this together as a global concept for the protection of vulnerable biodiversity in island systems (only islands – probably yes). .... Mauritius as a model for such protection in SIDS, which could well end up as a model for countries with much greater resources (note Hawaii and Canary Islands examples above!)

Species led conservation programmes so far (and justified when birds such as the Mauritius kestrel reduced to extremely low numbers). Original proposal has this but not as clearly emphasised points??

Need emphasis on ecosystems – both for the additional (in some cases undescribed) species or genetic diversity that these systems will contain, and for the functional value of the systems, which may be fundamentally altered by the invasion and dominance of exotic species. Example from Mauritius – cyclone resistance and catchment/soil erosion issues.

Note the lack of knowledge of what is there in many taxa
Serious issue of the number of taxa involved (e.g. insects in Mauritius – no. Described versus no. There? – for NZ this is currently .... 10000 described – minimum 20000 thought to exist??
Note the taxonomic impediment here for most groups of organisms (especially lower groups)

B. Project Documents

The originally proposed and accepted objectives, outputs and activities for the project are presented in the document:

GEF - UNDP Project : Restoration of Degraded Upland Forest in Mauritius. Project proposal. Mauritius Wildlife Appeal Fund.

The Tripartite Review, held at the beginning of the final year of the project, revised the outputs expected for the final 10 months of the project. These are presented in the report by Dr J. Hough and in associated documents:

Hough, J. 1998. Mission Report - Mauritius, 15B19 July 1998. United Nations Development Programme.

The original, accepted project proposal, and the Tripartite Review are summarised below, providing the baseline for the current final evaluation.

GEF - UNDP Project : Restoration of Degraded Upland Forest in Mauritius. Project proposal. Mauritius Wildlife Appeal Fund.

The proposal gives an overview of the geography and history of Mauritius, the recent progress by the Mauritian Government to integrate responsible environmental initiatives with development and the prior and on-going assistance with biodiversity conservation. The document includes a comprehensive justification of the project, detailing the global significance and highly threatened status of the native fauna and flora of Mauritius.

Concerning the "Expected End of Project Situation" the proposal states:

"It is expected that by the end of the project duration (3 years), a sound measure of control of invasive plants and restoration technique would have been developed. There will be a need for continued monitoring of the project site well beyond the project duration, at least for two more years in order to show that the site has been effectively restored"

Under project strategy, three main components were identified:

1/ Control of exotic weeds and animals: The success of the innovative methods used for total removal of exotic weeds by hand by trained teams, and mammal control by fencing and poisoning, is emphasized but acknowledged to be limited to small areas by labour constraints. A restoration ecology workshop was to be held to explore alternatives for the control of exotics and improve the restoration process. Note that the project only proposed to test the methods identified for control of exotic weeds.

2/ The second component was to make an assessment of the biodiversity of the area to be restored using University students and NPCS staff, under the supervision of specialists recruited under the project. They will assess both the exotic and native biodiversity and investigate their interaction. They will also monitor the response of the biodiversity to the control measures adopted.

3/ The third component was the restoration activity itself, applying the results of the initial experimentation in (1) above to an area of at least 5 hectares (in which the biodiversity had been previously studied in (2) above). *In situ* sowing of seeds and plantings were to be considered, but only if recommended by the workshop. An adjacent, unweeded area was to serve as a control.

The development objectives, immediate objectives, outputs and activities are all reproduced in full in the relevant section of this evaluation report.

Hough, J. 1998. Mission Report - Mauritius, 15B19 July 1998. United Nations Development Programme.

[This section needs a lot of tidying up – currently my comments interspersed with summary of Hough report]

Notes acute level of exotic plant invasion (35% of plants in tree and shrub layer are exotic – and this increases to 97% in seedling layer). This probably underestimates the impact to date ....

Table of project achievements given (comments below):

Noted weeding experimentation not started (has now)
University short course (Biodiversity Training Workshop) given twice (now 3x)
An extensive study of the biodiversity of the site has been carried out. Note that this has, where appropriate, been expanded to include other weeded CMA's and adjacent unweeded areas (and areas that have been weeded and restored for different time periods).
Fencing carried out, but no restoration work (propagation and reintroduction) – note endangered

endemic birds re-introduced into the Brise Fer area (and some nesting going on even in the 6ha mostly unweeded 'UNDP plot'). Re-introduction of native plants has not occurred in the 6ha plot (not weeded yet) but has occurred in the original Brise Fer CMA and in the new extension. Note that plantings have been relatively unsuccessful in the new extension (contiguous with the 6ha plot) because 2 deer were accidentally fenced in and not removed for most of the project duration (??). Even if the 6ha plot had been weeded, plantings would have been largely pointless without the removal of the enclosed deer (which have now been shot).
Notes that a full biodiversity monitoring system has not yet been devised (for the evaluation of the success of weeded and restored areas). This is in the process of being done, based on the studies of the biodiversity in weeded CMA's and in adjacent unweeded areas.

Notes emphasis of project has adjusted slightly, and sensibly, to focus more on the baseline survey and experimental testing of weeding methods rather than the restoration itself. This was probably predictable after the initial reduction of the project from a 5 year to a 3 year programme.

It was noted that the project design was equivocal regarding the extent that actual restoration work would be carried out. The design decided on only involves xx% of the 6 ha plot, and a decision needs to be made whether to weed the remainder (perhaps using Government Conservation Fund resources). The initial results of the weeding experiment, regarding cost-effectiveness and minimizing accidental damage to native plants, could be used to determine the weeding method chosen for the remainder of the plot.

As pointed out, youth groups were inappropriate...

Survey work took longer than expected (note need to cover whole season...)
Experimental design considered as behind schedule. Note – now done

Propagation and planting largely unnecessary... Note weeding and deer

Successful captive rearing and release programmes for pink pigeon noted, and at fairly advanced state for the echo parakeet.

Conclusion : slower progress than expected, but satisfactory and quality excellent.
Problems traceable to weaknesses in project design. (Yes – 5 year to 3 year, budget limitations led to reductions of project management component.

Capacity of NGO exceeded? Agree, but complicated by reduction in project management component and other problems with the project (e.g. lack of suitability of youth groups, lack of effective use of specialist consultants)

Recommendations: experimental design and treatments (now done). Apply to rest of 6 ha plot (can be done – but only after end of strict project duration). Evaluation – doing it!

Other key documents consulted

- Notes of Meeting. Tripartite Review Meeting on the Restoration of Highly Degraded and Threatened Native Forest in Mauritius, held on Friday 17 July 1998 in the conference room of the Ministry of Economic Development and Regional Cooperation.

- Recommendation - Workshop on the Restoration of Highly Degraded and Threatened Native Forests in Mauritius.

- UNDP/GEF sponsored Biodiversity Training Workshop. Compendium of Resources Given to Delegates. University of Mauritius, Faculty of Science, 12B17 January 1998.

- UNDP/GEF Project. Restoration of Highly Degraded Native Forest in Mauritius. Sixth Quarterly Progress Report, January – March 1998.
- (also reports 1-5, and later??)

- UNDP/GEF Project Implementation Review (PIR) Report, 1998

Some of my notes on this PIR report:

Performance indicators seem a slightly odd choice (fencing, biodiversity assessment, 2 of 3 training courses, International Workshop, Management Plan). No mention of student projects, weeding planned, proceedings planned from workshop...

Assumptions : Availability of qualified personnel (given a high risk), Three year time period allocated for the project (given a low risk?), Youth involvement in weeding (given a low risk?).

Implementation progress rating (of Immediate Objectives):
- Development of control measures against invasive exotic plants (Highly unsatisfactory)
- Assessment of the native biodiversity and capacity building in biodiversity assessment and monitoring (Highly satisfactory)
- Restoration of a pilot degraded ecosystem to its original state as far as possible with the involvement of youth groups (Highly unsatisfactory)

Reasons for difficulties – 1 and 3 require long-term for development and implementation (3 yes, 1 not so convinced about the long term nature of this part of the work – delays were caused by other reasons – the weeding expt is now finally being done). If 1 +/- 3 are long term, then surely the low risk on the 3 yr time scale is not correct?

Overall assessment – Satisfactory

Project Impact : highly satisfactory

III. Project Implementation

A. Activities

ACTIVITY (copied from project proposal)	COMMENTS
1.1.1 A meeting will be organized at the outset of the project to discuss with top restoration ecologists the different technologies available in weed control, to identify appropriate methodologies applicable to the local context and to define a strategy for the restoration of the native forest	The Workshop was successfully held (approx. 25 participants from 7 countries), although delayed until Sept 1997 (until the biodiversity surveys were mostly complete, and so that seasonal timing was appropriate). Recommendations were made on weed control and wider issues of restoration ecology in the National Park and elsewhere in Mauritius. A written proceedings is close to completion.
1.1.2 Various methods for controlling exotic plants including herbicides, mechanical removal and such other methods as may be identified in activity 1.1.1 will be assessed experimentally. The 5 ha experimental area will be fenced and a randomized block design will be set up within this area to carry out the experiments. The response parameters to be measured would include numbers of exotic plants eliminated, regeneration rate of exotic and native plants after treatment, use of the area by native animals subsequent to treatment compared to prior to treatment, effects on soil biota, human resources required to undertake the treatment, and time/cost attributes. The MWAF will be the main agency which will undertake this research.	These experiments were delayed until April 1999 (should have been set up shortly after the workshop above). It was not clear who would carry out the on-the-ground weeding, and eventually this has been funded by the Government from the Conservation Fund. Note that youth groups (see below) are inappropriate for this type of experimental work requiring consistency of methods and skills in the use of herbicides, chain saws etc. The experimental design (8 replicates per treatment, each of 100 square metre subplots, in a stratified random design is appropriate). Several of the longer term response parameters will have to be monitored by MWF and NPCS after the end of the project.
2.1.1 To provide course modules on biodiversity assessment and monitoring in the undergraduate Biology and Environmental Science courses at the University for the benefit of undergraduate students and also for staff of the NPCS so that they can be equipped for carrying out biodiversity survey and activities of the project.	Modules provided on conservation biology and ecosystems in biology undergraduate courses, and an MSc in biology is planned (inc. a module on environmental biology). A specific Biodiversity Training Workshop carried out 3x during project, for a total of approx. 140 trainees (mostly students but also NPCS and MWF staff). Good feedback and monitoring leading to further

	improvements to subsequent workshops
2.1.2 An awareness programme will be prepared for the youth participants so that they may be sensitized to the threats to and value of the biodiversity of the area they are working in and the relationship between the different components of the ecosystem. This activity will be undertaken by the interpretation section of the NPCS	Although this was perceived as a novel, low-risk aspect to the original proposal, youth participation turned out to be inappropriate. The Restoration Ecology Workshop emphasized the need for *thoroughly* trained weeding teams (which would be hard to maintain with youth groups). Weeding methods using herbicide and chainsaw use are also inappropriate for use by youth groups.
2.1.3 A survey of the flora, both angiosperms and lower plants, insects, molluses, vertebrates (mammals, birds and reptiles) and soil organisms will be carried out by specialists recruited under the project with assistance of students of the University of Mauritius and staff of the NPCS. This quantification will help to determine the different component parts of the forests and lead to a better understanding of the ecosystem. The Mauritius Herbarium will provide assistance in flora identification.	Surveys carried out successfully, but at times rather ad-hoc and could have been better planned. The use of specialist consultants, another innovative feature of the original proposal, was not always effective. Student projects were valuable. NPCS staff played only a little role in the surveys, but the training workshop has led to capacity building for the future. Because of the slow progress with weeding, the some of the surveys were conducted in the Brise Fer area as a whole rather than just the 6 ha 'UNDP plot'.
3.1.1 To build a fence around the study area to exclude ground mammals (all ground mammals in Mauritius are exotic). This work will be contracted out.	The fence constructed during year 1 of the project, but as an addition to an existing large plot (18ha) bringing the total fenced area up to approx. 24ha. This was a very efficient use of resources, because otherwise the budget allocation to fencing would only have allowed 1 ha to be enclosed.
3.1.2 Elimination of weed plants and the control of animal pests as specified by methods developed in activity 1.1.2. The work will be carried out by staff of the NPCS, MWAF and youth groups	The weeding delayed in part because youth groups were inappropriate for this activity. The Government Conservation Fund may be able to provide resources for the weeding of the non-experimental area within the plot (which is the vast majority of the plot area). Several deer accidentally fenced into the plot were not removed until April 1998, apparently because the Ministry of Agriculture failed to grant the necessary permission until well into the project. It has become clear that this inexplicable delay seriously affected the regeneration of native plants in the *entire* 24 ha fenced area, and resulted in high mortality in some re-introduced plants from the Curepipe nursery. Satisfactory control of rats (poisoning)

	and cats (trapping) was carried out by MWF
3.1.3 Seeds and other propagules will be collected from around the study area. Part will be sown *in situ* and part sown in the nursery at Native Plant Propagation Centre. The most threatened plants contained in the area will receive special attention and will be propagated for re-introduction.	Planting carried out in the original fenced CMA and also in the newly fenced area (but the latter with poor success because of the trapped deer – see above). Seed sowing was not recommended by the Restoration Ecology Workshop, so was not carried out. There was no planting in the 6ha area, because of the weeding delays.
3.1.4 Biotic components of the native ecosystem will be re-introduced into the project site by following re-introduction protocols developed by the IUCN/SSC Reintroduction Specialist Group. This will be thoroughly discussed during the meeting at the outset of the project.	Echo parakeets and pink pigeons have been released in overall CMA and monitored. The captive rearing and release of these endangered endemic birds is a major conservation success for Mauritius.
3.1.5 Regular monitoring of the re-introduced species will be carried out by staff of the NPCS and MWAF, and students of the University to insure that the re-introductions are successfully done.	Yes – monitored successfully. Note the continued need for rat poisoning, cat trapping etc in the area to increase the survival and breeding success of the released bird species.
3.2.1 Elements of biodiversity within the experimental and control plot will be monitored at regular intervals during the project in order that the success of the restoration effort may be assessed at the end of the project. Specific criteria including regeneration rate, changes in species diversity, use of the experimental plot by native bids and others will be measured. This will be undertaken by University students and staff of NPCS and MWAF.	One experimental and one control plot (non-randomly selected) is not statistically valid. Monitoring carried out in several CMA's and adjacent unweeded sites (a better design). Delays in weeding meant that much monitoring went on in the other parts of the Brise Fer site. Permanent quadrats are in place for studying plant regeneration and monitoring of these will continue. Student projects were a successful outcome. NPCS has only had a little direct involvement, but capacity has been built, through training, for the future. Given reduction in the length of the project from 5 to 3 years at the start, this activity has been a success.
3.2.2 Results of surveys and other restoration efforts will be disseminated through scientific publications, reports and other media.	A full report was produced on the biodiversity survey. A scientific paper has been prepared on the comparison of numbers of butterfly species in weeded and unweeded areas. ?Others

B. Quality of monitoring and backstopping

The most important monitoring mechanism for the project was the Technical Advisory Committee (TAC) which was typically comprised of a representative from the following bodies:

- National Parks and Conservation Service (TAC Chairperson was the Director of NPCS, Mr Y. Mungroo, who was also the Project Director)
- UNDP
- Mauritian Wildlife Foundation
- University of Mauritius (UOM)
- Mauritius Sugar Research Industry Research Institute (MSIRI)
- Ministry of Economic Planning and Development
- Ministry of Youth... sport...
- Others?

TAM met approximately each 3 months
Need for better communication between MWF and TAC Chairman (NPCS)
Did not appear to be an adequate understanding or knowledge of the objectives and proposed outputs of the project among most members of the Technical Advisory Committee.

One of the reasons for this poor communication was probably that project management in MWF was stretched at times though the programme, probably due largely to the lack of funding for a project manager position (as originally specified in the first proposal to UNDP/GEF). Nevertheless there appears to be a need for some project management training within this NGO, and this is likely to be particularly important if the NGO takes on the implementation of several larger programmes simultaneously (see also comments in tripartite review report by Dr J. Hough).

Project Evaluations

There was no mid-term evaluation of the project despite this process being planned, and budgeted for, in the project proposal. A review at this stage could have identified the time constraints inherent to the project due to the 3 year duration, and recommended a re-phasing and re-structuring of the objectives.

The UNDP Regional Representative, Dr J. Hough carried out a Tripartite Review in July 1998 (just into the 3rd and final year of the project). This review, although constrained by time, identified several key problems and uncertainties with the project and produced a revised set of outputs with a timetable for the remaining 10 months of the project.

PIR Report....

Evaluation of the Biodiversity Training Workshop

Evaluation reports were produced on the three Biodiversity Training Workshops, analyzing the evaluation forms completed by the students and other attendees (or from discussions only in the case of the first workshop). The completed forms were sent to the UNDP Office in Port Louis.
Each report assesses the perceived strengths and weaknesses the workshop, and makes recommendations. There was clear evidence that the recommendations from the first workshop were followed up in the subsequent year, indeed to such an extent that little modification was necessary for the final, 3rd year workshop. The increasing numbers of participants, and demand for further expansion, is another sign of the success of the workshops.

Anything to say on where students have gone ... or on to do what? Some capacity building gains are

hard to judge or longer term (e.g. the next crop of professionals and politicians might include people with more awareness if biodiversity issues). But can we say anything concrete on more immediate outcomes?? Yes ... students undertaking projects, keen to form a volunteer weeding group..

Summarising the overall recommendations from the 3 evaluation reports:

- Residential would be preferred (to allow evening work/presentations and build on course camaraderie)
- Marine as well as terrestrial
- Participatory exercises wherever possible (great – note some presenters may find this very novel – and field work where this type of activity can occur in many cases does have logistical problems – see below comment on transport)
- Increase to more than one week (allow for project work..!)
- University transport unreliable (note other aspects of Univ role/collaboration were entirely satisfactory)
- Produce a simple field guide to Mauritian biodiversity, and make sure this is available along with appropriate handouts prior to the relevant sessions.
- Speaker quality?? More visual aids and more participatory approach (year 1), some monotonous (year 2), written material available in time (years 1 & 2 – done in year 3). Even in year 3 ... "not all talks were universally well received".

Note : course handbook produced (for students). ??Should something more be produced e.g. guide to running the course so that lessons learnt, both in general and those specific to the Mauritius environment, do not need to be re-learnt if such a course is to be repeated in the future. At least the practical exercises should be written up, and not just the lectures...

Evaluation and monitoring of other University of Mauritius activities relevant to the project

Student projects associated with the project were subject to the usual review process within the University of Mauritius. Internal and external examiners (inc. one from overseas)
Any conclusions?? E.g. Hassell comments about statistical perceptions especially grasping probability issues in sampling and analysis of field data.

Note follow up of employment of graduates has led to the University canceling its Environmental Science degree course, and concentrating on providing modules on Environmental Science and Ecology in the standard Biology course. With the opportunities for later specialization in undergraduate projects, the planned MSc on ....., and in PhD programmes, this decision seems appropriate.

IV. Project Results

A. Relevance

The overall purpose of the project as stated in the proposal was to 'halt the degradation of the native forests caused by exotic weeds and animals and to restore to the extent possible the original structure and functions of the forest ecosystem'. There were three main components:

1/ Using a workshop of restoration experts and field experiments, find the 'best methods for the control of exotic weeds in the forest ecosystem'.
2/ Assess the biodiversity in the area to be restored, investigate the interaction between exotic and native components of the biodiversity, and monitor the responses of the biodiversity to the measures adopted to control alien invaders.

3/ Apply the results of the initial experimentation to an area of at least 5 hectares, the biodiversity of which has been previously studied.

The overall purpose is still highly relevant to the Convention on Biological Diversity: the indigenous fauna and flora of Mauritius is of global biodiversity significance, has suffered in the past from the destruction of habitats and is currently under great threat from the impacts of invasive alien animals and plants.

The concept of the conservation and restoration programmes in Mauritius acting as a model for other regions in the world (especially SIDS) is still valid.

The programme has relevance to sustainable development in Mauritius through the potential for increasing the importance of eco-tourism. There are also aesthetic and social values associated with the conservation of indigenous biodiversity. In additions there are some current medicinal uses for indigenous plants, and probably future potential. The potential future value for genetic stock should be recognized, particularly for wild, endemic plants in important economic taxa (e.g. *Coffea* spp.).

B. Efficiency

In general, efficiency in the project has been very high: the project was deliberately restricted to US$200,000, which although leading to problems in the design and implementation has resulted in a high level of cost-effectiveness. Comments in several specific areas are given below:

Youth groups for weeding activities
The plan to use youth groups for the time-consuming weeding failed to deliver, so parts of the programme have required more resources than expected. The Government of Mauritius has mobilized extra resources to fund weeding teams from their Conservation Fund.

University of Mauritius
The project budget allocated to the University was raised at the final stages of initial project planning from $5000 to $15000. This was clearly a very good investment in terms of the outcomes achieved (modules in degree courses, three Biodiversity Training Workshops and student projects on ecology and conservation).

Specialist consultants
The use of local, specialist consultants was an innovative feature of the programme, but in the end this is one area where the project does not seem to have been particularly cost-effective. In broad terms the overall cost-effectiveness of the consultant component of the project probably balances out and is reasonable, but only because additional inputs were provided from other sources e.g. university staff and students, MWF staff and volunteers. Continuous monthly 'retainers' were paid to the selected consultants, but there appears to have been little monitoring of their outputs relative to the outputs specified in the signed contracts. It would have been better to have specified time allocations to these outputs and operated these consultants on a more rigorous sub-contractual basis with reports on outputs being required before the appropriate payments were made. This lack of cost-effectiveness in some of the consultancies in a project that was overall extremely tightly budgeted is unfortunate, and particularly so when the fees to the consultants were a significant component of the overall budget.

Technical Advisory Committee
The Technical Advisory Committees (chaired by the Project Director, Mr Y. Mungroo) and with representatives from several government ministries, MSIRI, UOM etc, functioned efficiently, although more regular communication between MWF and the Project Director would have avoided some misunderstandings.

MWF project management

The project management by MWF can be criticized (see section ...) but strictly in terms of cost effectiveness is satisfactory because of the small monetary inputs involved (US$23000 over three years). More effective management could have been provided has a full time project manager been included in the project (as recommended in the original 5 year proposal).

C. Objectives

OBJECTIVE	
D1. Development of control measures against invasive exotic plants	A valid and important objective that will be achieved by the end of the project, although the necessary field experiments were delayed until the final year.
D2. Assessment of the native biodiversity and training of staff and students in biodiversity assessment and monitoring	Baseline surveys of the native biota were a necessary objective, and were achieved very satisfactorily. Training and capacity building of staff and students was excellent.
D3. Restoration of a pilot degraded ecosystem to its original state as far as possible with the involvement of youth groups.	This objective has only been partly achieved, but would have required longer than 3 years. There were also major problems with the use of youth groups, which meant that alternative resources needed to be found.

D. Outputs

Table of outputs in the project proposal. Comments on the successful achievement or otherwise, clarifications and possible explanations have been added in column 3.

OBJECTIVE	OUTPUT	COMMENTS
D1. Development of control measures against invasive exotic plants	1.1 To determine through consultation and experimentation the most effective measure (use of herbicide and/or other means) for controlling exotic plants	The workshop of international restoration ecology produced a set of recommendations for research and implementation of weed control and on wider issues of restoration ecology in the National Park and elsewhere in Mauritius. A written proceedings of this workshop and a specific Management Plan for the Brise Fer Forest 1999-2003, are additional, unplanned outputs of the project. The experiments following on from the workshop, although delayed, have identified the most appropriate herbicide to be used, and will produce a weeding method that is more cost-effective, faster and results in less non-target damage to the valuable indigenous biota that is the target for conservation.
D2. Assessment of the native biodiversity and training of staff and students in biodiversity assessment and monitoring	2.1 To train staff of the NPCS and students of the University in techniques of biodiversity assessment and monitoring and to create awareness within the youth community to the importance and significance of biodiversity conservation and habitat restoration. About 4 staff of NPCS and 2 students a year, over	Modules provided on conservation biology and ecosystems in biology undergraduate courses, and an MSc in biology is planned (inc. a module on environmental. Awareness in the youth community has only been partly achieved through the general use of media, and there was no participation of youth groups in any project activities as was originally planned. A specific Biodiversity Training Workshop carried out 3x during project, for a total of approx. 140 trainees (mostly students but also NPCS and MWF staff). A major successful outcome of the project in terms of collaboration and capacity building.

	3 years will receive training.	
	2.2 A study of the biodiversity will be undertaken at the project site in order to document the difference components of the biodiversity	Although planning could have been better, the overall outputs from the biodiversity surveys has been very good. A detailed report was produced part way through the project (and scientific papers will be produced – see below).
D3. Restoration of a pilot degraded ecosystem to its original state as far as possible with the involvement of youth groups.	3.1 Restore the project site so as to enhance regeneration of native species and provide better habitats for native animals	The 6 ha project area has only been partially restored. Animal control has been satisfactory (although the delay before the 2-3 deer accidentally fenced *inside* the plot were shot was highly unfortunate). Weeding has been restricted to several small experimental sites and was delayed until April 1999, but the inappropriateness of youth groups was a major factor causing this delay. No plantings of rare species were carried out in the 6 ha site primarily because of the lack of weeding. Some plantings carried out in the original fenced CMA and also in the newly fenced area (but the latter with poor success because of the trapped deer – see above). Echo parakeets and pink pigeons have been released in overall CMA and monitored successfully. Note the continued need for rat poisoning, cat trapping etc in the area to increase the survival and breeding success of the released bird species.
	3.2 Produce a monitoring system to examine the effects of restoration of the native forest ecosystem, population dynamics of components of diversity.	A monitoring system has been produced with various methodologies appropriate for each selected taxa. This has been published in the form of a report and several scientific papers are drafted or planned. The final project report will compile this information (see Appendix xx for a summary of available information). Because the 6 ha plot was only partially restored, most of this work has been carried out in the adjacent fenced area at Brise Fer. Given reduction in the length of the project from 5 to 3 years at the start, this output has been a success.

E. Development Objectives

The proposal states that "the overall development objective of the project was to restore remnant native upland forest that has been degraded by invasive exotic plants and animal species to a more natural state in order to conserve this unique forest type and to protect remaining elements of highly threatened native biodiversity found therein".

This overall objective remains highly valid, but to what extent have the project activities resulted in progress towards this overall objective? Several key outputs from the project that indicate progress are presented below:

- The Restoration Ecology Workshop produced useful recommendations, both for animal and weed control in the Brise Fer area, and for the conservation of biodiversity in Mauritius in general.

- More cost-effective and appropriate weeding methods are being tested, and these should facilitate restoration programmes in the future. However only a small part of the 6 ha plot set up during this project has been weeded to date.

- There is now a significantly improved capacity within Mauritius to help achieve biodiversity restoration work in the future. On-going incorporation of modules on ecology and environmental science in the biology course at the UOM should continue this trend. Indication that the Government of Mauritius is committed to the objective: as indicated by the effective use of the Conservation Fund (e.g. to cover the weeding costs in this project, and more widely to undertake sizeable conservation measures such as the elimination of rats from Flat Island). The recent increase in the number of staff in the NPCS also indicates support and commitment. The Government as also keen to see the current forest restoration programme being followed up.

- Elements of biodiversity that need protecting are now better known (including the identification of new species to science, and highlights such as re-discovery a large endemic beetle species not seen since 1926). This will allow for improved monitoring of measures taken in the future, and a monitoring system has been set up under the existing project.

F. Effectiveness

Restoration Ecology Workshop. Effective in that key international experts were brought to Mauritius and assessed the situation and made recommendations (many of which have been or are being followed up, both in the current project and in the broader conservation effort in Mauritius). The Proceedings is an extra output that will make the discussions and recommendations more widely available in Mauritius and elsewhere in the world.

Brise Fer Forest Management Plan. A good output, in addition to the project objectives, but clearly too early to assess it's effectiveness.

The experimental trials of the weeding methods are underway, and the design and implementation are good, so they should produce effective results (allowing the evaluation and selection of the most appropriate, cost-effective weeding method for the Brise Fer forest). Within the project duration, some aspects of the experiment will not be effective because they will require long term monitoring (but assume MWF/NPCS will continue this after the end of the current project).

Were the Biodiversity Training Workshops effective? Yes in terms of no.s of trainees. But was training useful? Students going on to use this training in projects? NPCS staff – not immediately used training, but important to understand issues and techniques. MWF staff – some used in programme??

designed and implemented, but can only be assessed after it has been published and available for some time. The Brise Fer Forest Management Plan is a good output, in addition to the project objectives, but clearly it is too early to assess it's impact on the forest. It does however provide a framework and set of targets for the future management of the area, and hence facilitate the process of restoration (e.g. by making it easier to justify the allocation of resources to restoration and conservation work).

The impact of the experimental trials on new weeding methods will be the restoration of a small area of forest. Establishing a cost-effective and appropriate method for weeding large areas of this forest is expected to have a large impact by increasing the area of forest that can be restored.

The main impact of the training has been the greater capacity in biodiversity conservation in Mauritius. MWF and other NGO's active in the conservation area, as well as NPCS, will be able to make use of this. ?Recent appointment of 5 new technical officers by NPCS (?did any of these receive training through UOM, Biodiversity Training Workshop, or projects etc?). Improved links with UOM/MWF/NPCS in this training.

The biodiversity surveys have had an impact by demonstrating the benefit to many taxa from weeding and exclusion of alien animals. A new species of snail was discovered and a Cratopus sp. weevil not seen since 1926, and only previously known from 4 specimens (in London and Paris), was recorded in the canopy mistblowing. Impact is that enough is known to develop a thorough monitoring system.

Impact of restoration activities...
Impact of animal control activities –
Improved regeneration of native plant species and better survival of plantings from the nursery indicate that exclusion of these large herbivores has had an impact (although this information is not from the 6 ha 'UNDP plot' as this has not been weeded).

From the increased survival of native birds it is clear that the control measures against predatory animal species are effective.

Impact of weeding – not known in 6 ha plot

Echo parakeets actively forage on the fruit of their preferred canopy trees, and may already be playing a role in seed dispersal of some of these tree species

Impact of reports, media etc... ?? Too soon to say for reports and scientific papers. Media coverage??

I. Sustainability

A key question. One of the major aims of the project was to develop improved weeding methods that were more cost-effective and yet equally (or more) effective as part of an ecosystem restoration process.

Training etc looks good. Biodiversity Training Workshops will only run if funds are provided to the University, but they will maintain the ecological and environmental modules within their biology degree course.
Government commitment appears to be increasing over time (as evidenced by the setting up of the National Park and the NPCS, recent increases in staff, and the use of the Conservation Fund)
But sustainability of the basic weeding methods and the control methods for alien animals is a critical issue.
Labour costs (the development of volunteer culture is important – but maybe premature to operate via youth groups via Ministry of Youth and Sport)
Next project needs to address the issue of sustainability of the conservation measures

UOM – resources used effectively? Students projects – yes (many useful outputs – directly to project and in general biodiversity conservation). Modules in courses provided and on-going.

Biodiversity surveys have been carried out effectively for the various taxonomic groups. A report was produced and key taxa covered as well as baseline data in large groups such as the molluscs and insects obtained

Restoration of the project site:
To date this has been only partly effective, but it was an unrealistic objective within the 3 year duration of the current project. A fence was constructed and pigs and deer excluded (but only finally effective when 2 deer trapped inside the plot were shot). Continuous rat poisoning and trapping of predators such as cats has taken place in the newly fenced area. Weeding, using the newly developed methods, has not been carried out.

Endemic and endangered pink pigeons and echo parakeets have been captive reared and released in the general Brise Fer fenced area. The pink pigeon breeds in the area, but the populations would not survive without the continuous control of rats and cats. Nevertheless the active choice of the weeded and restored areas of the Brise Fer CMA by these birds indicate that the process of restoration is producing a habitat suitable for this species. The echo parakeets have not bred in the area yet. Monitoring of these introduced bird species is regular and effective.

Sufficient work has now been conducted on elements of the biodiversity in the Brise Fer fenced area to produce an effective monitoring system for evaluating the response of the indigenous biota to the restoration process.

Reporting and dissemination of the results is on-going, but has been effective to date. MWF makes good use of media (magazine articles, video footage etc) to publicize the conservation work in Mauritius.

G. Capacity Building

Excellent with University. Students doing courses in Biology and Biology with other sciences are offered modules in environmental science and ecosystems. The stand-alone environmental science degree course has been discontinued because students were not getting employment after the course, and a biology degree with environmental/ecological options was considered more appropriate. The programme specifically funded three Biodiversity Training Workshops, which included both lectures and hands-on practical training in for example, biodiversity assessment and monitoring techniques. This was attended by students, NPCS staff and MWF staff. The course was very successful, with good monitoring and feedback from evaluation reports, and trained a total of approximately 140 people.

MWF capacity to manage the overall programme does appear to have been strained by the need to run on a low budget and attempt to fit a 5 year programme into 3 years. A full time project manager with a scientific background would have helped, and should be built in to any future programme. Training in project management would be beneficial.

Youth groups failed (but recent group of Mauritian volunteer weeders – most of whom have attended and benefited from the Biodiversity Training Workshops).

H. Impact

The restoration ecology workshop has had a good impact with several of its recommendations being carried out. The proceedings is expected to have an impact on how similar restoration projects are

J. Overall Appraisal ... to add

References

Strahm, W. 1996. The vegetation of the Mascarene Islands. Curtis=s Botanical Magazine 13: 214-237
Others to add

Documents consulted during evaluation (in addition to the Project Documents listed in Section II.B)

Florens, F.B.V., Dulloo, M.E. & Boucherville Baissac, P. de. 1998. Brise Fer Forest Management Plan, 1999-2003. Draft. Mauritian Wildlife Foundation, Port Louis, Mauritius.

A Strategic Plan for the Mauritian Wildlife Foundation, 2000-2009. A proposal from the Executive Staff for consideration by MWF Council, November 18, 1998.

Summary Agreement for the Implementation of the Mauritius Biodiversity Restoration Project. GEF Agreement Reference Number: 28398-MAS

Contract for Implementation of Ecological Restoration of Highly Degraded and Threatened Native Forests Project. MAR/93/G 31 (UNDP). Agreement between Ministry of Agriculture and Natural Resources *and* Mauritian Wildlife Appeal Fund.

Vision 2020. The National Long-term Perspective Study. Volume II. Ministry of Economic Development and Regional Cooperation, 1997.

Government of Mauritius. National Environmental Strategies for the Next Decade: Review of Legal and Institutional Framework for Environmental Management in Mauritius, February 1998. Report prepared by the Environmental Resources Management, London.

Government of Mauritius. National Environmental Strategies for the Next Decade: Environmental Priorities in the Republic of Mauritius, April 1998. Report prepared by the Environmental Resources Management, London.

Government of Mauritius. National Environmental Strategies for the Next Decade: Seminar 1 Proceedings, April 1998. Report prepared by the Environmental Resources Management, London.

Mauremootoo, J. 1997. A brief report on the UNDP/GEF funded biodiversity training/workshop: 9-14 December 1996. Unpublished report, MWF, Port Louis, Mauritius.

Mauremootoo, J. 1998. A brief report on the UNDP/GEF funded biodiversity training/workshop: 12-17 January 1998. Unpublished report, MWF, Port Louis, Mauritius.

Mauremootoo, J. 1999. A brief report on the UNDP/GEF funded biodiversity training/workshop: 11-16 January 1999. Unpublished report, MWF, Port Louis, Mauritius.

Western Indian Ocean: Global Environment Outlook. First Draft. United Nations Environment Programme, and Commission de l'Océan Indien.

Government of Mauritius. Mauritius NEAP II: Environmental Strategy Options Report. May 1998. Report prepared by the Environmental Resources Management, London.

United Nations Development Programme: **Country Cooperation Framework and Related Matters.**
First Country Cooperation Framework for Mauritius (1997-1999)

Itinerary of Dr Simon V. Fowler, during visit to Mauritius, 26 April - 8 May 1999.

Sunday 25 April	Arrive Mauritius
Monday 26 April	Met Mr Y. Mungroo (Director, NPCS) at SADC Workshop at Marisa Hotel Meetings with Dr J. Mauremootoo and Mr P Baissac (MWF) in Port Louis
Tuesday 27 April	Meetings with Mr C. Hare (Chairman, MWF), Drs C. Jones and J. Mauremootoo at MWF Office, Port Louis. Meeting with Dr M. Verdickt (UNDP)
Wednesday 28 April	Visit to project field site at Brise Fer with Drs Mauremootoo and Jones.
Thursday 29 April	MWF Office, Port Louis. Meeting with Dr Magda Verdickt and document access at UNDP Office.
Friday 30 April	Field visit to Ile aux Aigrettes, and discussions with staff associated with the World Bank/GEF Restoration Project.
Saturday 1 May	Reading and report preparation
Sunday 2 May	Free
Monday 3 May	Meeting with Mr Ganeshan, Entomologist, MSIRI. Meeting with Mr Y. Mungroo (Director, NPCS) and Mr V. Bachraz.
Tuesday 4 May	Meeting at Ministry of Agriculture with Mr R.P. Nowbuth (Principal Assistant Secretary), Mr C. Bhugun (Assistant Secretary) and Mr Y. Mungroo.
Wednesday 5 May	Meeting with Dr M. Bhikajee (Head, Dept. Biol. Sci., UOM), Mr R. Dulymade and Mr V. Bachraz. Meeting with Dr J. Williams (Entomologist, MSIRI, and project consultant). Visit NPCS Plant Propagation Nursery at Curepipe and meeting with Mr V. Tezoo (NPCS) and Dr J. Mauremootoo (MWF).
Thursday 6 May	Report preparation. Discussions with Mr P. Baissac (MWF)
Friday 7 May	Agreed and signed contract at UNDP. Meeting with Dr M. Verdickt and telephone conversation with Mr K. Hill (UNDP, New York)
Saturday 8 May	Meeting with Ms A. .... (Entomologist working part time for MWF) and Dr J. Mauremootoo (MWF).
Sunday 9 May	Depart pm for New Zealand.

Acronyms

GEF Global Environment Facility
JWPT Jersey Wildlife Preservation Trust
MSIRI Mauritius Sugar Industry Research Institute
MWF Mauritius Wildlife Foundation (previously known as the Mauritius Wildlife Appeal Fund)
NPCS National Parks and Conservation Service, Government of Mauritius
UNDP United Nations Development Programme
UOM University of Mauritius

Others to add

Glossary

CMA Conservation Management Area (one of the fenced and weeded areas in the Black River Gorges National Park)

Mistblowing A technique where insecticide is blown up (in this case) into the canopy of a forest and the falling insects collected at ground level (in this case on polythene sheets spread out over an area 10m x 10m).

Randomised block design A design of a field experiment where different treatments (e.g. different weeding methods) are each applied to several blocks (each say a 10m x 10m area of forest).

RTU Recognizable Taxonomic Unit. The best (or most appropriate) classification of organisms in a sample, usually based on visual assessment (microscopic in some cases), hopefully approximately to species (or other higher level taxa if rapid identification to species is impossible).

Taxa Any recognized level of classification of an organism or organisms e.g. species (or sub-species), genus, family and so on. See also RTU

Others to add

Terrestrial Biodiversity-related BSc projects completed by students who attended the UNDP/GEF-funded biodiversity training workshop

1997

Ghoorbin, H.B. Plant diversity and regeneration studies in conservation management plots in the upland humid forest at Brise Fer.

Moodhoo, D. A study of the population structure of native plant species growing on Ile aux Aigrettes.

Nundoll, A. Studies on the spatial dynamics of native *Coffea* species.

Seerungen, M. Population ecology of endemic *Phelsuma* species on Ile aux Aigrettes.

1998

Padayachy, N. The effects of weeding on populations of endemic day geckos in Brise Fer.

Prosper, A. An ethnobotanical survey of plant resources in Rodrigues.

Geddedu, S. River fauna of Mauritius as bioindicators of water quality.

1999

Eydatoulah, Noorinah. Native Mauritian fruits as hosts for economically damaging fruit fly species.

Eydatoulah, Noorinah. The effects of conservation management on tree seedlings in a Mauritian native forest.

Gooljar, D. Time partitioning studies on an introduced species of gecko in Mauritius

Seegoolam, V. Effect of conservation management on native fern regeneration in an upland Mauritian forest.

Biodiversity studies relevant to the undp/gef project

Findings from the studies outlined below will be included in the final report of the UNDP/GEF project. The results gained will be used to establish the monitoring methods to be used in the future UNDP/GEF project.

Species groups which were monitored in the course of the UNDP/GEF project in order to assess the effects of management on biodiversity

Species group	Methods used	Source
Birds (native and non-native)*	Transects	Hill (unpublished data)
Land snails (native and alien)	Nested quadrats and inventories	Florens 1996
Phelsuma geckos	Quadrats	Florens (unpublished data) Padayatchy 1998
Insects	Mist blowing, malaise trapping, light trapping, pitfall trapping	Nababsing et al. (unpublished data)
Butterflies	Transects	Mauremootoo et al. (in prep.)
Native trees & shrubs	Quadrats	Florens (unpublished data), Hurdowar & Poonyth), (unpublished data), Ghoorbin (1987), Eydatoulah (1999)
Orchids	Quadrats, inventories and autecological studies	Roberts (1999) and unpublished data
Native and non-native pteridophytes	Quadrats	Seegoolam (1999)

* Observations on released and managed populations of birds were not recorded because of the many confounding factors which would make it difficult to assess the effects of plot management.

Studies on other key species in the UNDP/GEF study area

Species	Methods used	Source
Pink pigeons	Intensive monitoring of birds	Groombridge (1998), Swinnerton (in prep.), MWF field staff (unpublished data)
Echo parakeets	Intensive monitoring of birds	Groombridge (1998), MWF field staff (unpublished data)
Rats (*Rattus rattus* & *Rattus norvegicus*)	Index trapping	Hall (unpublished data)
Mongooses	Trapping & radio tracking	Roy (unpublished data)

Study on ecosystem function in the UNDP/GEF study area

Predation rate studies using artificial baits	Carter (unpublished data)