DEPARTMENT: ENVIRONMENTAL AFFAIRS AND TOURISM
REPUBLIC OF SOUTH AFRICA

# CAPACITY BUILDING PROGRAMME FOR CLIMATE CHANGE RESEARCH

## Climate change and its effects on terrestrial biocomplexity: the Prince Edward Islands as exemplars and sentinels

## I. Programme design and establishment

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## 1. Introduction

This document provides a detailed design for a Capacity Building Programme for Climate Change Research that has been established by the University of Stellenbosch (see ANNEX A), based on the extended proposal drafted in conjunction with the South African Department of Environmental Affairs & Tourism and submitted to the USAID office. The major aims of this programme are: 1. to contribute to the development of the necessary human resource capacity that will allow South Africa to enhance its ability both to predict the impacts of climate change on its biodiversity estate, and to mitigate the effects of this change; and 2. to develop a deeper understanding of the likely impacts of climate change on these levels, and their interactions, so as to be better able to predict the likely future course of climate change events both in the southern ocean and elsewhere. This has to be done via a training and research programme that will lead to the higher education of a minimum of nine B.Sc. (Hons.), seven M.Sc., and three Ph.D. students, the majority of whom are drawn from previously disadvantaged population groups, and by means of a research programme that will address the following objectives: 1. Determine the change in relationships between species richness and functional group diversity across the elevational gradient, a useful surrogate estimate of climate change, at Marion Island; 2. Investigate the limits to growth and activity of species and the ways in which these limits govern species performance; 3. Determine the extent of phenotypic plasticity and genetic variation in key indigenous and introduced species and the extent to which this might allow differential success under climate change scenarios.

The goals of the research programme are addressed in the original proposal (at Annex B), and here we set out the way in which this capacity building programme has been designed to address the its goals.

## 2. Overall Structure

The overall structure of this programme is one where a Central Office at the Department of Zoology, University of Stellenbosch (hereafter the Central Office) will coordinate the Programme. The Central Office will be staffed by the Project Manager, Prof. S.L. Chown, who is on the full-time staff of the University of Stellenbosch, and Mr. Richard Mercer, who has been contracted by this programme as the Research Coordinator. Although students registered at the University of Stellenbosch will undertake much of the research work, a substantial portion of the work will also be subcontracted to students at other institutions, including the University of Durban Westville and other historically disadvantaged institutions.

The Central Office will be responsible for coordinating all of the research and for liaising directly with Mega-tech Inc., USAID/South Africa, and the Department of Environmental Affairs & Tourism (DEA&T) and especially the Directorate Antarctica & Islands (DEAT, DAI), which is responsible for logistics at the Prince Edward Islands, and who will also bear all logistic costs for this work.

The Central Office will also be responsible for reporting, both in terms of progress with the programme, and in terms of financial control. The Central Office will also take overall responsibility for ensuring that the programme functions smoothly and achieves its goals.

**3. The Capacity Building Programme : Student Appointments and Grants**

The overall goal of the programme is advanced student training of graduates from historically disadvantaged backgrounds using a programme twinning experienced (Ph.D. level) and inexperienced (M.Sc. and B.Sc. Hons. level) researchers. To ensure that this goal is met several basic criteria must be adhered to. Perhaps the most important of these are that all students must be registered at a South African University and be South African citizens of holders of permanent residence permits for South Africa. At the B.Sc. (Hons. level) students may be registered at any South African University for a *bona fide* B.Sc. (Hons.) degree in the animal or plant sciences, or science education/awareness. At the Masters and Doctorate levels, it is envisaged that the students will register as follows:

| **Research Field** | **Project Leader & Institution** | **Masters** | **Ph.D.** |
|---|---|---|---|
| Molecular Systematics | Dr. S. Daniels[1] (U. Stellenbosch) | 1[1] | 1 |
| Insect Physiology | Prof. S. L. Chown (U. Stellenbosch) | 1[1] | 1 |
| Insect Ecology | Dr. D.J. Marshall (U. Durban-Westville)[2] | 1[1] | 1 |
| Sheathbill Ecology | Dr. P.G. Ryan (U. Cape Town) | 2[1] | |
| Plant Ecology | Prof. V.R. Smith (U. Stellenbosch) | 1[1] | |
| Science Awareness | Prof L. Rabe (U. Stellenbosch) | 1[1] | |

[1]from a historically disadvantaged population group; [2]from a historically disadvantaged University.

In addition to these basic criteria, there are specific requirements at each of the training levels.

**3.1. B.Sc. (Hons.). level**

A minimum of nine students will be funded to the value of R 15 000 *per annum* each, with an additional R 5000, awarded to their supervisors, to cover the running costs of the project. Travel costs for these students for the relief trip to Marion Island will be provided from the Central Office. The Honours students have to be from previously disadvantaged groups (here defined using the National Research Foundation's criterion of students who are either Black, Asian or Coloured). All of these students and their supervisors will be expected to sign an agreement with the University of Stellenbosch specifying certain conditions of award. This contract is at Annex C. In addition, prospective supervisors of students who have applied for the position will be sent a letter setting out conditions of award (Annex D).

The students must travel to Marion Island for the one month long relief voyage and must undertake the research components of their project on a field related to the climate change programme. It is envisaged that these students will receive further training in the programme at the Masters and Ph.D. levels, though this is not necessary. Although project flexibility will be retained owing to the academic level of training, students working in ecology and science awareness will be sought. The B.Sc. (Hons.) students will each receive funding for a maximum of one year.

Although every effort will be made to attract students from historically disadvantaged Universities, the findings of the recent Higher Education Report, that the majority of black students now attend the historically advantaged ("white") Universities should be kept in mind.

If no suitable candidates can be found, the funding will be rolled over for a maximum of one year and the search procedure repeated. It is expected that this will be sufficient to ensure that only historically disadvantaged students enter the programme at this level.

**3.2. M.Sc. level**

A minimum of seven students will be funded to the value of R 35 000 per annum each for a maximum of two years, with the choice of a once-off amount of R 9000 of these funds being allocated to computer equipment. Running costs of between R 35 000 and R 15 000, depending on the field and the year of study will be awarded. Travel costs for these students for the relief trip to Marion Island will be provided from the Central Office, as will travel and subsistence costs for the "Team Training" period required by DEA&T in Pretoria in advance of the Marion Island expedition. These students have to be from previously disadvantaged groups (here defined using the National Research Foundation's criterion of students who are either Black, Asian or Coloured) if possible. If this is not the case, project leaders must provide documentary proof that the positions were advertised nationwide and that no applicants from previously disadvantaged groups were found who were acceptable for the position. In this case, the Central Office will reserve the right to advise project leaders of suitable applicants from disadvantaged groups. In any case, all appointments of students will have to be agreed to by the Central Office. All of the successful students and their project leaders will be expected to sign an agreement with the University of Stellenbosch specifying certain conditions of award. This contract is at Annex C.

**3.3. Ph.D. level**

A minimum of three students will be funded to the value of R 45 000 per annum each for a maximum of two years, with the choice of a once-off amount of R 9000 of these funds being allocated to computer equipment. Running costs of between R 35 000 and R 15 000, depending on the field and the year of study will be awarded. Travel costs for these students for the relief trip to Marion Island will be provided from the Central Office, as will travel and subsistence costs for the "Team Training" period required by DEA&T in Pretoria in advance of the Marion Island expedition. These students will be selected on the grounds of excellence regardless of their population group membership. All of the successful students and their supervisors will be expected to sign an agreement with the University of Stellenbosch specifying certain conditions of award. This contract is at Annex C.

**4. Ensuring Capacity Building Requirements**

To ensure that student appointments are made in keeping with the capacity building requirements of the programme, all student appointments will be subject to assessment by the Central Office and by the DEA&T Directorate Antarctica & Islands (DEA&T, DAI).

In addition, the following processes will be adopted to ensure that the capacity building requirements of the programme are met.

**4.1.** B.Sc. (Hons.) positions will be widely advertised electronically (see Annex E for an example) (funds do not allow for newspaper advertisements) and in a once-off advertisement in the South African Journal of Science. The positions will also be advertised on the project home page, the URL of which will be advertised on the signature line of both the Project Leader and Research Coordinator. This URL will also be distributed via the networks of the scientific societies, and in a once off advertisement in the South African Journal of Science. The advertisements will state that at this level only students from previously disadvantaged groups should apply for the positions. If previously disadvantaged students do not apply for the positions, the positions will be carried over for a maximum of one year. If more students apply than the allotted number of positions, the students will be ranked based on their academic excellence as judged by scores in the final year of the B.Sc. degree. The best students will be selected. Where students are of equivalent status, female candidates will be preferred. If students do not supply all the required documentation in a timely fashion they will be excluded from the process. However, students will be sent one reminder for submission of documentation, as will their prospective supervisors. Students not in possession of a valid passport and who have failed to obtain a medical certificate stating that they are in good health and documenting their blood group, will immediately be disqualified. The student adjudication will be undertaken by the Central Office. All documentation will be filed and will be available for scrutiny by DEAT/USAID.

**4.2.** At the Masters level, student positions will be advertised on the electronic distribution networks of South African Scientific Societies (e.g. Zoological Society of Southern Africa) and the National Research Foundation. Here, it will be made clear that the positions are for students from previously disadvantaged groups. The positions will also be advertised on the project home page, the URL of which will be advertised on the signature line of both the Project Leader and Research Coordinator. This URL will also be distributed via the networks of the scientific societies, and in a once off advertisement in the South African Journal of Science. Furthermore, all project leaders will be sent documentation (at Annex F) indicating that Masters students must be from previously disadvantaged groups. If neither the Central Office, nor DEA&T DAI, nor the project leaders themselves can find suitably qualified students (i.e. B.Sc. (Hons.) or equivalent accepted by the University in question), then consideration will be given to other students. However, this will only be done after agreement in writing, between the three parties above, stating that all search avenues for students from previously disadvantaged groups have been exhausted. If more students apply than the allotted number of positions, preference will be given based solely on academic excellence as judged by scores in the final year of the B.Sc. (Hons.) degree as well as the student's research performance to that date. The adjudication will be undertaken by the project leader in conjunction with the Central Office. Where students are of equivalent status, female candidates will be preferred. If students do not supply all the required documentation in a timely fashion they will be excluded from the process. However, students will be sent one reminder for submission of documentation, as will their prospective supervisors. The majority of the

Masters students (the exceptions may be Molecular Systematics because of the absence of an appropriately equipped laboratory on Marion Island) will be required to undergo the usual DEA&T DAI interview and full medical. If they do not pass muster here, they will be excluded. This requirement is a standard requirement set by DEA&T, DAI for students spending 12-13 months at Marion Island. All students will require a passport valid for the period during which they will be at Marion Island. Failure to meet this requirement will result in their exclusion. For students spending only the relief at the island, failure to obtain a medical certificate stating that they are in good health and documenting their blood group, will result in their disqualification.

**4.3.** At the Ph.D. level all project leaders/supervisors are expected to select students based on excellence of their academic record (research excellence and marks in previous degrees) irrespective of their population group membership. However, in the case of equivalent students, students from disadvantaged groups will be given preference. Student selection will be the responsibility of the project leaders, although the project leaders will have to report on the selection procedure to the Central Office. If students do not supply all the required documentation in a timely fashion they will be excluded from the process. However, students will be sent one reminder for submission of documentation, as will their prospective supervisors. The majority of the Masters students (the exceptions may be Molecular Systematics because of the absence of an appropriately equipped laboratory on Marion Island) will be required to undergo the usual DEA&T DAI interview and full medical. If they do not pass muster here, they will be excluded. This requirement is a standard requirement set by DEA&T, DAI for students spending 12-13 months at Marion Island. All students will require a passport valid for the period during which they will be at Marion Island. Failure to meet this requirement will result in their exclusion. For students spending only the relief at the island, failure to obtain a medical certificate stating that they are in good health and documenting their blood group, will result in their disqualification.

**5. Managing Student Performance**

**5.1.** Once students are in the programme there is no guarantee that they will complete their degrees. However, the students and project leaders will be required to sign a contract (at Annex C) with the University of Stellenbosch, stipulating that failure to deliver will result in their having to return funds, with the amounts dependent on the point at which they resign from the programme.

**5.2.** At the B.Sc. (Hons.) level, all grant payments will be made in two installments. The first installment (all running expenses and 50% of the bursary) will be paid at the start of the project, whereas the remaining 50% of the student bursary will be paid mid-year. All students and their supervisors will be expected to submit a short mid-year progress report indicating that the student’s progress with the work is adequate. On acceptance of this report by the Central Office (dispute resolution will be in accordance with University of Stellenbosch procedures), the second payment will be made to the student. At the end of the year, supervisors must submit a final report, which includes hard and electronic copies of the student’s project, and proof that the student has qualified for the degree.

**5.3.** At the M.Sc. and Ph.D. levels, running funds will be released on an annual basis, and the student bursary will be paid in two installments (at the start of the year and at mid year). The second installment of the bursary will depend on receipt from the project leader of a short report indicating that the progress of the student is satisfactory. The student must countersign this document (or a facsimile thereof if the student is based at Marion Island). An annual report will be required from all project leaders detailing progress on the project and providing an assessment of student progress. This report must be in the form of and meet the requirements of the standard DEA&T DAI Interim Progress Reports. Funds for continuation of the work in the following year will only be released following acceptance of this report. The reports will be accepted, rejected, or returned for revision following the procedure set out in Section 6 below. On completion of the project all project leaders will be required to submit a final report in accordance with the specifications of Project Final Reports set out by the DEAT DAI in their Programme Director's manual. They will also be required to submit verification that the students under their supervision have qualified for the degrees as required by this programme.

**5.4.** If any students or their supervisors/project leaders fail to deliver satisfactorily, they will be excluded from the Programme and the remaining funds will be returned to the University of Stellenbosch. Disputes in this regard will follow the University of Stellenbosch grievance and dispute resolution procedure. The remaining funds will be consolidated and every effort will be made to appoint other students and researchers to complete the work.

**6. Managing Research Performance**

**6.1.** All supervisors and project leaders will be expected to provide annual reports based on the DEA&T DAI format. These reports will be consolidated into a single report by the Central Office and this report will be put forward to all relevant parties. In particular, it will be submitted to the DEA&T Climate Change Office, and the South African Committee on Antarctic Research (SACAR) for evaluation in the same manner used for all research undertaken within the auspices of the South African National Antarctic Programme (SANAP).

**6.2.** In addition to reporting to SACAR, to ensure that the research goals of the programme are being met, and that the programme retains sufficient flexibility to respond to new findings elsewhere, two independent scientific assessors will be appointed. The envisaged assessors are Prof. Kevin J. Gaston from the Biodiversity & Macroecology Group, Department of Animal & Plant Sciences, University of Sheffield, United Kingdom (see Invitation Letter at Annex G), and Prof. Albert S. van Jaarsveld of the Centre for Environmental Studies of the University of Pretoria, South Africa. The scientific assessors will evaluate the annual progress reports produced by the Central Office. Based on the evaluation they will identify strengths and weaknesses of the programme and make recommendations regarding the ways in which funds are being utilized and in which research problems are being addressed. The scientific assessors will also assist in identifying synergies between the projects and will provide advice regarding interactions with other groups involved in similar research.

**6.3.** The Project Leader, Research Coordinator, Scientific Assessors, and two representatives nominated by the DEA&T (of which at least one will be from DEA&T, DAI), Head of Zoology at the University of Stellenbosch, and a member of the Research Development Office at the University of Stellenbosch will constitute a Programme Steering Committee (PSC) that will meet at least once annually to discuss the overall progress of the Programme. The members of the PSC will have an opportunity to air concerns or suggestions regarding the programme and replies to these or strategies to address them will have to be provided, in written form, by the Central Office in conjunction with the relevant Project Leaders, within two months of this meeting. Funding for travel of the scientific assessors will first be sought from outside the programme budget.

## 7. Reporting

### 7.1 Quarterly Reports

Written quarterly reports will be submitted to Mega-tech Inc. on progress of the programme regarding the four outputs/deliverables. The submission dates for these reports are 3rd May 2002, 3rd August 2002, 3rd November 2002, and 1st February 2003.

### 7.2 Annual reports

An annual report on capacity building, research progress, and expenditure will be prepared by the Central Office after receiving reports from all the participating project leaders and supervisors. This report will be submitted to DEA&T and USAID/South Africa at the end of January. The report will first have to be approved by the scientific assessors and the PSC before final submission. The report will contain the following sections:

*1. Introduction and Summary of Goals*

This section should include a brief history of the programme, its major goals, and changes to these goals that have been made following suggestions of the scientific assessors and the PSC.

*2. Capacity Building*

Here, the numbers of students currently in the programme, those who have completed their studies and are graduating (including qualifications level and name of institution), and the population groups of these students will be reported.

*3. Research Progress*

Here, research progress will be documented in narrative style. Documentation should not exceed 15 typed pages, excluding references.

*4. Research Outputs*

Research outputs will be listed under the headings: Peer-reviewed research papers, Chapters in peer-reviewed books, Books, Presentations at International and National Conferences, Posters at International and National Conferences, Published Abstracts.

*5. Popular contributions*
These outputs will be listed under the headings: Popular Articles, Popular Books, Media Appearances, Web page addresses (dated to the most recent update of site).

*6. Expenditure*
Here, a summary of all expenditure will be provided based on the budget items provided in the detailed budget of the Mega-tech Inc. Contract No. 0102-S-02. This summary of expenditure will not constitute an audited statement of the accounts. Such an audited statement will be provided separately, within the same calendar year, by the Directorate Finances & Services of the University of Stellenbosch, countersigned by the Project Manager.

### 7.3. Annual Report Processing
Following submission of the annual report, DEA&T and USAID/South Africa will be requested to respond to the report within three weeks of receipt of it. If no comment on the report is received in writing it will be presumed that the report is accepted. If the report is not accepted, the Central Office must be notified in writing of the reasons for rejection of the report. The PSC must then be notified and avenues for addressing the problems should be sought. These avenues should be identified in conjunction with the DEA&T and USAID/South Africa, and would likely involve project leaders within the programme.

Should the report prove to be acceptable, it will be submitted to SACAR. The Chair of SACAR should respond in writing within three weeks of its annual meeting. If no response is received it will be presumed that the report is accepted. If concerns are raised regarding the progress, these should be referred to the PSC who will then take the matter up with all relevant parties and respond in writing.

## 8. Logistics
This programme is heavily dependent on logistic support from the DEA&T, DAI, which is responsible for all operations at Marion Island. Logistics for the programme will be coordinated from the Central Office. The following procedure will be adopted.

1. All project leaders and supervisors of B.Sc. (Hons.) students will be required to liaise directly with the Research Coordinator for logistic requirements for Marion Island. The requirements must be submitted before mid-January.

2. The Research Coordinator will liaise directly with the Officer in Charge (OIC) of the Marion Island Expedition for arrangement of logistics for the programme, including logistics pre-departure, during the voyage, and after its return.

3. The Research Coordinator will also be responsible for coordinating the protective clothing requirements for the staff on this project and seeing to the management of this process.

4. Costs of transport of equipment and personnel to Cape Town will be covered as per the detailed budget submitted to USAID/South Africa (Annex B).

5. Any logistic difficulties will be negotiated between the DEA&T OIC and the Research Coordinator. In cases where the dispute cannot be resolved at this level the Project Manager and the Director: Antarctica & Islands will resolve the problem.

**9. Annual Activities for Central Office**

| Date | Activity | Responsibility | Assessment Criterion |
|---|---|---|---|
| January | Request for updated student statistics | R.D. Mercer | Letters/e-mails submitted to project leaders/supervisors |
| January | Receipt of project reports | Project leaders to R.D. Mercer | Receipt of report |
| January | Preparation of Annual report | S.L. Chown/R.D. Mercer | Acceptance by PSC/DEA&T /USAID |
| January | Audited financial statements | U. Stellenbosch | Acceptance by PSC/DEA&T /USAID |
| January | Circulation of annual report | R.D. Mercer | Report circulated by e-mail. |
| January | Logistics liaison | R.D. Mercer | Acceptance of SACAR 3 form by DEA&T DAI |
| January | Final Hons. selection | S.L. Chown/R.D. Mercer | Letters of award to students/supervisors |
| February | Schools preparatory contact | R.D. Mercer | Letters of expression of interest |
| February | PSC meeting | S.L. Chown | Minutes of meeting |
| February[2] | Quarterly Report to Mega-Tech Inc. | S.L. Chown and R.D. Mercer | Acceptance of report |
| February[2] | Summary report on programme to Mega-tech Inc. | S.L. Chown and R.D. Mercer | Acceptance of report and release of funds |
| February[2] | Funding release | Mega-tech Inc. | Receipt of funds by U. Stellenbosch |
| February | Request for updated student statistics | R.D. Mercer | Letters/e-mails submitted to project leaders/supervisors |
| March | (Re-)Appointment of Research Coordinator | S.L. Chown and U. Stellenbosch | Signed Contract |
| March[1] | Submission of Programme Design | S.L. Chown | Acceptance by USAID/South Africa |
| March[1] | Funding release | Mega-tech Inc. | Receipt of funds by U. Stellenbosch |
| March | First batch of student appointments | S.L. Chown/Supervisors/Project Leaders | Confirmation of registration |
| March | First funding release | U. Stellenbosch | Fund transfer documentation |
| March[1] | Agreement of Project | S.L. Chown/Project | Letters of agreement |

| | Leaders to Participation | Leaders | |
|---|---|---|---|
| March[1] | Establishment of home page | R.D. Mercer | Provision of URL and appearance of site at U. Stellenbosch/Zoology |
| March | Logistic preparation/packing | Project leaders | Submission of packing forms |
| March | Logistics liaison | R.D. Mercer | Documentation from OIC DEAT |
| April[1] | Establishment and fund study grant pool | S.L. Chown and U. Stellenbosch | Documentation from U. Stellenbosch Research Development Office |
| April[1] | Funding release | Mega-tech Inc. | Receipt of funds by U. Stellenbosch |
| April[1] | Establish and fund supervisory and management structures | S.L. Chown and U. Stellenbosch | Documentation from U. Stellenbosch Research Development Office |
| April[1] | Funding release | Mega-tech Inc. | Receipt of funds by U. Stellenbosch |
| April[1] | Submission of Advertisement to SAJSci | R.D. Mercer | Appearance of advert |
| May[1] | Quarterly Report to Mega-Tech Inc. | S.L. Chown and R.D. Mercer | Acceptance of Report |
| May | Updating of homepage | R.D. Mercer | Change in site content |
| June[1] | Schools programme initiated | R.D. Mercer | Documentation of school visits |
| July | Mid-year reporting | Supervisors/Project leaders | Receipt of reports |
| July | Mid-year fund release | U. Stellenbosch | Fund transfer documentation |
| August[1] | Quarterly Report to Mega-Tech Inc. | S.L. Chown and R.D. Mercer | Acceptance of Report. |
| August | Schools programme continued | R.D. Mercer | Documentation of school visits |
| September | Tertiary education institution visits | R.D. Mercer | Documentation of presentations |
| September | Request for project annual reports | R.D. Mercer | Letters of request |
| October | Logistic needs | R.D. Mercer | Documentation to project leaders |
| October | Hons. Position advertisement | R.D. Mercer | Circulation by list servers |
| November | Quarterly Report to Mega-Tech Inc. | S.L. Chown and R.D. Mercer | Acceptance of Report. |
| November | Annual report reminder | R.D. Mercer | Letters to project leaders/supervisors |
| November[3] | Workshop on progress | S.L. Chown/R.D. Mercer | Workshop report |
| December | Hons. position | S.L. Chown/R.D. Mercer | Short-listed applications |

| | | | |
|---|---|---|---|
| | preliminary decisions | | |
| December[1] | Liaison with Antarctic Data Centre, Australia | R.D. Mercer | Undertaking of collaboration |

1. Once-off activities for 2002 only.
2. Once-off activities for 2003 only.
3. Two workshops over course of programme.

**10. Signatures**

**Project Manager**

**Research Coordinator**

**Date**

**Date**

**Director: Research**

**Date**

**11. List of annexes**

ANNEX A. Letter Documenting Establishment of Programme

ANNEX B. Letter Documenting Sole Use of Funds

ANNEX C. Original Submission to USAID from DEA&T

ANNEX D. Student and Supervisor Contract

ANNEX E. Conditions of Award of Hons. Bursaries

ANNEX F. Advertisement for Hons. positions

ANNEX G. Conditions of Award of M.Sc. and Ph.D. Bursaries

ANNEX H. Invitation to Scientific Assessor

**ANNEX A. Letter Documenting Establishment of Programme**

**ANNEX B. Letter Documenting Sole Use of Funds**

**ANNEX C. Original Submission to USAID from DEA&T**

# RESEARCH PROGRAMME IN CLIMATE CHANGE: PROPOSAL

## Climate change and its effects on terrestrial biocomplexity: the Prince Edward Islands as exemplars and sentinals

Submission from
Directorate Antarctica & Islands, Department of Environmental Affairs & Tourism

**A. Summary**

Global climate change is a serious, complex threat facing both human and other life. As a consequence of its interaction with habitat destruction and the worldwide human distribution of invasive species, global climate change is posing a significant threat to the biodiversity estate that humans are totally dependent on for their welfare. In consequence, the Framework Convention on Climate Change has urged nations to develop an understanding of the impact of climate change on their biodiversity estate, as well as plans for mitigation of its effects. As is the case in many other countries, the South African science community faces a lack of appropriate information and skilled human resources to deal effectively with these requirements, both with regard to its continental biodiversity estate, and the southern ocean, which forms one of its most significant resource bases. In order to develop a more comprehensive understanding of marine and terrestrial systems so as to better predict the likely impacts of climate change, there have been several calls, most significantly in the context of an International Long Term Ecological Research Programme, for the establishment of a programme of climate change research and science capacity development. It has been suggested repeatedly that the sub-Antarctic Prince Edward Islands (and especially the larger, Marion Island) should form a key component of such a program. There are several reasons for this. First, because of its generally low number of species, well documented cases of invasion by aliens, and considerable altitudinal gradient in diversity, Marion Island is at once more straightforward to investigate than biodiverse continental systems, yet it is also wholly comparable to such systems. Second, the terrestrial and marine systems of the islands are closely linked in a feedback loop that is now beginning to be understood. Third, Marion Island has shown significant climate change both in the geological past, and over the last 50 years, and this change is having effects, on both the terrestrial and marine systems, that have been documented in preliminary investigations. Finally, the islands have been subjected to only minimal human disturbance, most of which has been well documented, thus allowing investigations of biocomplexity that are not confounded by continual human interference.

Here, an integrated research programme investigating the ways in which climate change is likely to affect biocomplexity at several hierarchical levels in terrestrial systems is set out. The major aims of this programme are: 1. to develop a deeper understanding of the

likely impacts of climate change on these levels, and their interactions, so as to be better able to predict the likely future course of climate change events both in the southern ocean and elsewhere; 2. to contribute to the development of the necessary human resource capacity that will allow South Africa to enhance its ability both to predict the impacts of climate change on its biodiversity estate, and to mitigate the effects of this change.

This will be done by means of a five-year research programme that will address the following research objectives

- Determine the change in relationships between species richness and functional group diversity across the elevational gradient, a useful surrogate estimate of climate change, at Marion Island,

- Investigate the limits to growth and activity of species and the ways in which these limits govern species performance,

- Determine the extent of phenotypic plasticity and genetic variation in key indigenous and introduced species and the extent to which this might allow differential success under climate change scenarios,

**B. Background and significance**

Global climate change is a complex, largely, self-induced change confronting humans and the biodiversity estate on which they rely. In order to deal with the uncertainties associated with climate change, the Intergovernmental Panel on Climate Change (Watson *et al.* 1996) regularly evaluates available evidence to formulate a consensus opinion on likely outcomes. The present view is that a global mean temperature increase of approximately 2°C is a realistic expectation over the next 50 years (McNeely *et al.* 1995). Moreover, because large-scale extinctions, and movements of species were precipitated by major climate changes in the past (Coope 1995; Roy *et al.* 1996), an ability to predict the biodiversity consequences of an immanent climate change event is becoming increasingly important (McNeely *et al.* 1995). Indeed, although most conservation biologists recognize that habitat destruction is probably the most significant threat to global biodiversity, increasingly they are realizing that without a sound understanding of the likely effects of the climate change wildcard, their efforts may be compromised at best, and in vain at worst (Soulé 1991). Indeed, there is little doubt that the combined effects of climate change, coupled with human population growth patterns and increasing *per capita* consumption patterns will result in major changes to biodiversity over reasonably short timescales (Gates 1993). Hence there is an urgent need for understanding and predicting climate change effects on this biocomplexity.

Assessing the consequences of climate change on biocomplexity is no trivial scientific task. Not only are ecosystems hierarchically complex (Eldredge 1996), but species might also either adapt to changes in climate or simply move (Coope 1995; Hoffmann & Parsons 1997). Furthermore, these responses are likely to mean that some species will benefit while others will suffer under conditions of climate change (Fajer *et* *al.* 1989; Freedman 1989; Cammell & Knight 1992; Davis *et al.* 1998a, b). Thus, community compositions as we know are likely to change, as species distributions change, rather than shift position, resulting in new spatial configurations and community compositions (Coope 1995; Jablonski & Sepkoski 1996). Moreover, because of species connectivity in food webs, changes in community compositions could precipitate secondary species extinctions and invasions resulting in novel species interactions and more radically reorganized communities (Karieva *et al.* 1993; McNeely *et al.* 1995). Indeed, because such second order, or indirect, effects are poorly understood in the climate change context (see Davis *et al.* 1998a, b), it has been suggested that amongst the best advice ecologists can provide managers is that the latter should be on the lookout for "ecological surprises". These surprises are likely to be even further exacerbated as humans reorganize communities by means of the deliberate or unintentional introduction of alien species, the third major threat to global biodiversity (Soulé 1991; Case 1996; Williamson 1996). Indeed it is this biological homogenization coupled with the speed at which climates are changing and the rapid human destruction of natural habitats that most clearly distinguishes current from past changes, and that has set conservation, and in many cases political, alarm bells ringing globally.

Because of the urgency of the problem and the complexity of the field, a variety of international scientific programs have set about examining the likely effects of global change at several levels in the ecological hierarchy, including those such as the International Tundra Experiment, TIGER in the United Kingdom, and the International Geosphere-Biosphere Programme. Furthermore, under the aegis of the Framework Convention on Climate Change (ratified by South Africa in 1997, DEA&T 1998) countries have had to provide climate change adaptation and mitigation plans and strategies (see e.g. Kerr & Packer 1999; Van Jaarsveld *et al.* 2000), of which several have been supported by the US country studies program.

These studies have adopted one of several approaches. For example, much climate change work in the Arctic has made use of greenhouse-type cloche experiments, open-top chambers, and several other field-based methods of manipulating climate and investigating species and community responses (Coulson *et al.* 1996). In the UK, field-based work has been concerned also with individual species responses to climate over altitudinal and or latitudinal ranges (Fielding *et al.* 1999) or with climate-associated variation in interactions between a few species in well-known systems (Buse *et al.* 1999). Laboratory-based work has also sought to investigate species interactions under different climate regimes to determine the extent to which climate-matching approaches, perhaps the most widely used methods for predicting species-level responses to climate change (see Jeffree & Jeffree 1996), are likely to be confounded by novel interactions. Other approaches have included documenting recent changes in species characteristics, most notably their range positions (Parmesan *et al.* 1999) or body sizes (Smith *et al.* 1998), from data sets that have a sufficiently long time series.

All of these studies have made considerable contributions to current understanding of the interactions between species, ecosystems and climate, but all are confounded in a variety of ways (which the proponents of the methods usually acknowledge). For example, hidden treatments are often difficult to discern in both laboratory experiments and field manipulations (Kennedy 1995; Huston 1997), and alternative hypotheses can sometimes not be adequately distinguished. In addition, many laboratory assessments makes use of just a few, very widely distributed species (see Davis *et al.* 1998a,b), and the direct bearing of these studies on natural ecosystems is difficult, if not impossible to assess. In climate matching studies it is often the case that one or more of the range edges of a given species are not well-predicted by climate variables (MacArthur 1972; Root 1988; Parmesan *et al.* 1999), while in field manipulations the manipulated climate is often substantially different to the one predicted by climate change models (see Kennedy 1995 for further discussion). Furthermore, the difficulty of monitoring multiple migrations of species from elsewhere, associated both with high human traffic and broad continental connections, makes assessments of the influence of climate change on interactions between alien and indigenous species on most continents problematic (Bergstrom & Chown 1999).

One way to circumvent many of the above problems, and to integrate the findings done at a variety of hierarchical levels (e.g. community responses vs. those of individual species) is to investigate concurrently, at several levels, systems that are reasonably species poor, though being sufficiently diverse to remain relevant to richer ones, that have just a few well-known and key alien species, that have low levels of natural migration and human-mediated introductions, that have both a range of climates and are showing distinct signs of rapid climate change, and that are reasonably well-known scientifically. The islands of the southern ocean are just such systems. As such they provide model laboratories where the current and likely future impacts of climate change on natural systems can be assessed and understood in a manner where confounding influences can be reduced to a minimum (Bergstrom & Chown 1999).

Southern ocean islands (Fig. 1) have well-developed terrestrial ecosystems that represent a continuum of increasing complexity from the low diversity Antarctic to the species rich and vegetationally complex continents to the north. For example, vascular plant species richness ranges between zero (the rather anomalous Bounty Islands) and 188 (Auckland Islands), and insect species richness varies from a low of six on McDonald Island, to well over 200 on the Auckland Islands. Even on a single island, and this point is important in a climate change context, the range of habitats can be striking. For example, on sub-Antarctic Marion Island, lush nitrophilic temperate grasslands occur in coastal regions, while bryophytes dominate at elevations above 500 m. At 800 m there is little vegetation save for a few lichen species, while at 1200, the island is virtually devoid of vegetation (Gremmen 1981; Smith 1987a). Furthermore, most of these islands have ecosystems that are significantly influenced by the marine-terrestrial interaction. Not only does the vast southern ocean buffer climate, but large numbers of seabirds and seals also bring nutrients and energy ashore (Smith 1987a). This feedback loop is closed as eddy effects and nutrient run-off from the islands influence marine productivity and the areas where the marine organisms forage, and consequently where their pelagic predators, such as seabirds and seals, congregate.

The direct impact of humans on the southern ocean islands has also, for the most part, been slight (Smith & Lewis Smith 1987; Young 1995), and their biotas are remarkably intact (see Steadman 1995 for discussion of island extinctions). Nonetheless, humans have had indirect impacts on a considerable number of these islands as a consequence of the introduction of invasive plants and of synanthropic mammals (Gremmen 1981; Bonner 1984; Chapuis *et al.* 1994; Young 1995). However, a sufficient number of islands has remained either free of invasive plants and feral animals (e.g.

Smith & Lewis Smith 1987; Chapuis *et al.* 1994), and/or has had their feral animals eradicated or controlled (Dingwall 1995), to warrant their consideration as pristine islands. Thus, most islands harbour a few key alien species whose biologies and interactions with indigenous species are reasonably straightforward to assess and in some cases have been monitored for several years (see e.g. Copson & Whinam 1998; Gremmen & Smith 1999).

The southern ocean islands were also affected markedly by past climate change. For example, at Marion Island, two, or perhaps three glacial phases occurred during the Neogene. Likewise, Îles Kerguelen, Heard Island and South Georgia carried extensive glaciers during the last glacial maximum (Hall 1990), from which they are still emerging. In general, those islands currently lying to the south of, or close to the Antarctic Polar Frontal Zone (APFZ) (Fig. 1), and/or those that are larger and higher, tended to be more heavily glaciated than those lying to the north of the APFZ, and/or those that have smaller areas and lower elevations. Some of the more northerly, and smaller islands, such as Auckland, Campbell and Macquarie Islands, may not have been glaciated at all (Selkirk *et al.* 1990). Thus the position of islands with regard to the APFZ, and the movement of the latter, are among the most important factors that have influenced the climatic history of the islands (Hall 1990). Indeed, it is the position of the frontal zones in the southern ocean, and their movements relative to the islands that continue to have a marked effect on terrestrial and marine systems in the area, and that are showing dramatic responses to climate change.

Since the inception of meteorological recording at islands in the southern Ocean in the 1940s, there has been a marked change in their climates. This trend is especially clear at Marion, Kerguelen and Macquarie Islands (Adamson *et al.* 1998; Smith & Steenkamp 1990; Frenot *et al.* 1997). Since the late 1940s, but most noticeably since the late 1960s, mean annual temperatures have increased by at least 1°C (illustrated for Marion Island in the upper panel of Fig. 2, with the continuous line representing a three-year running mean). Over the same period mean annual precipitation has declined by as much as 500 mm on Marion Island and Îles Kerguelen (illustrated for Kerguelen in the lower panel of Fig. 2, with the solid line representing a three-year running mean). These changes are having pronounced direct and indirect effects on the local biota (e.g. Klok & Chown 1997), and, perhaps more importantly in the light of global concerns, their interactions with introduced species. For example, on Marion Island, in areas away from high nutrient sources, (such as penguin colonies) nutrient input into the terrestrial system is low, and most nutrients are recycled from litter via a microbial and macro-invertebrate detritus chain. Larvae of a tineid moth, *Pringleophaga marioni*, process large amounts of litter and consequently act as a bottleneck in the supply of nutrients. However, these larvae also form the prey of introduced house mice on Marion Island, which appear to be having an increased impact, associated both with elevated temperatures and reduced rainfall (making conditions more favourable for mice) (Smith & Steenkamp 1990), and perhaps also the recent extermination of cats (Van Aarde *et al.* 1996). As a result of these interactions, and direct impacts of mice on both other insect species and plants (mostly seed predation), the effects of climate change on Marion Island, and its mouse-free neighbour Prince Edward (only 22 km distant) are proceeding quite differently (Fig. 2) (Smith & Steenkamp 1990; Chown & Smith 1993). One of the consequences of this increasing impact of mice is manifesting itself amongst Lesser Sheathbills (*Chionis* *minor*), the only terrestrial bird species indigenous to the islands. Lesser Sheathbills rely heavily on invertebrates for winter survival, and spend much of their time foraging inland for them (Huyser *et al.* 1999). However, the extent of this inland foraging appears to be much reduced on Marion compared to Prince Edward islands, and in recent years Sheathbill populations have seen a significant decline at Marion Island, while remaining unchanged at Prince Edward (Fig. 3).

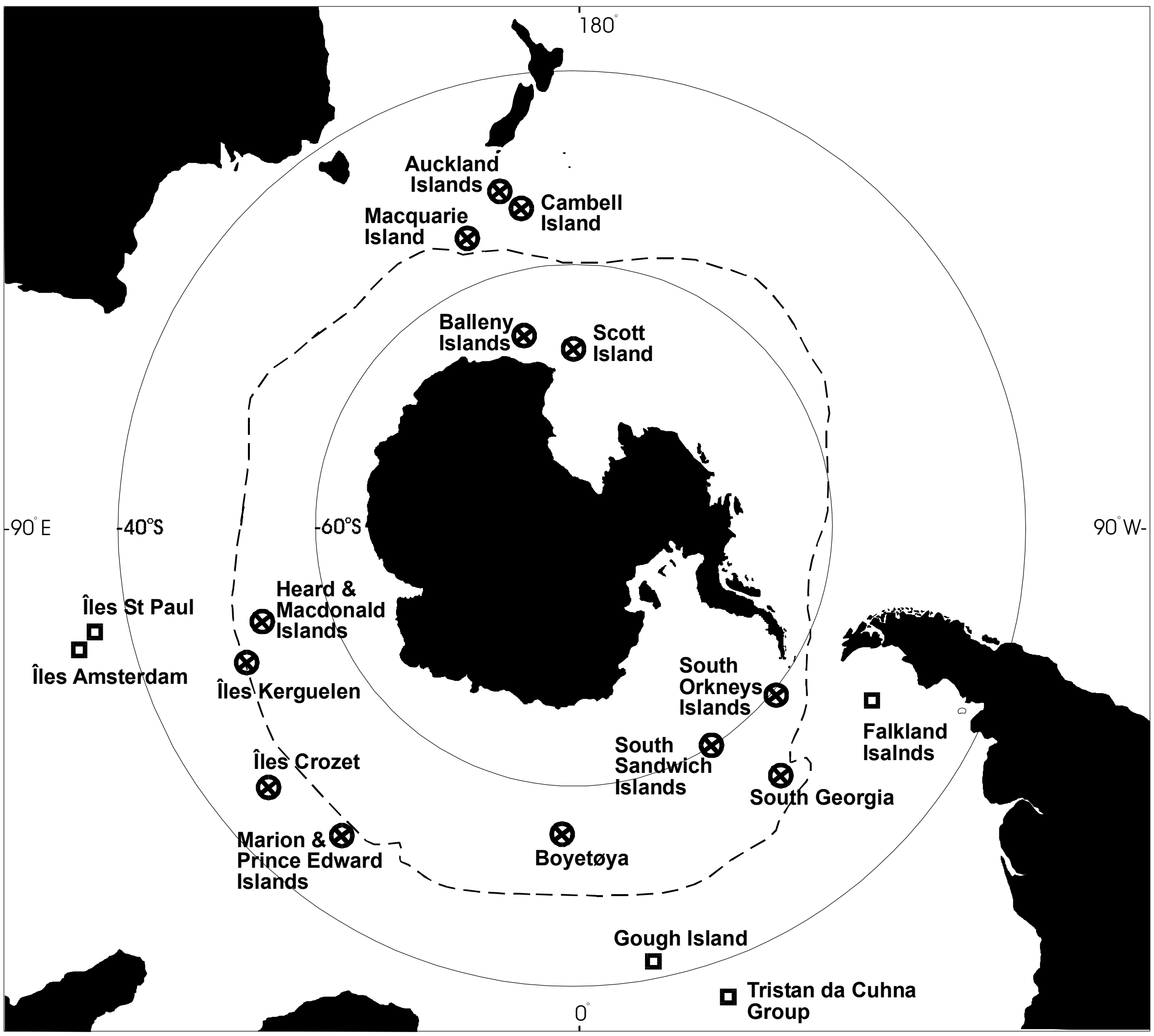
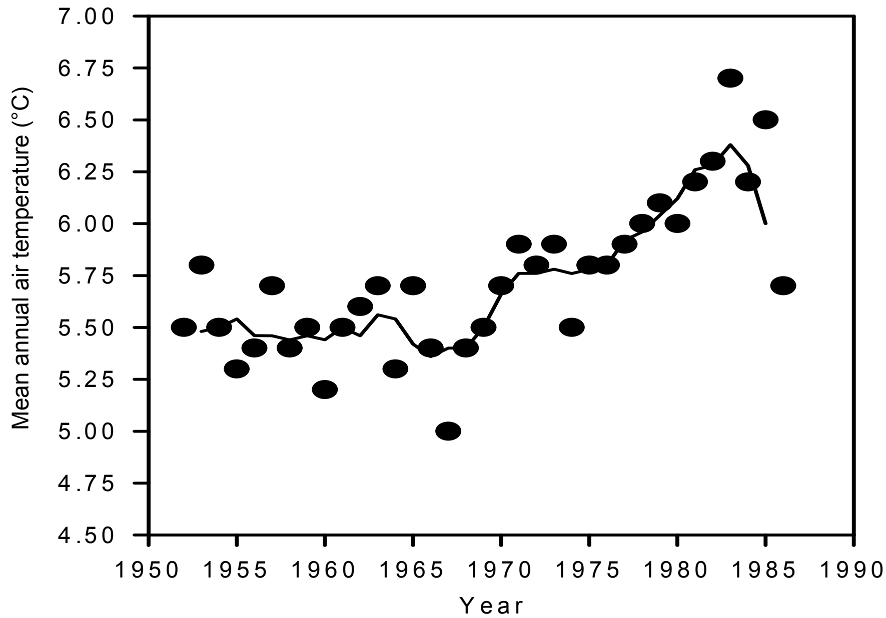



Figure 1. Antarctica and the Southern Ocean, showing the locations of the sub-Antarctic islands and the Antarctic Polar Front Zone (APFZ) (dashed line). During the last glacial maximum (18000 years ago) the APFZ lay north of islands marked by crossed circles.



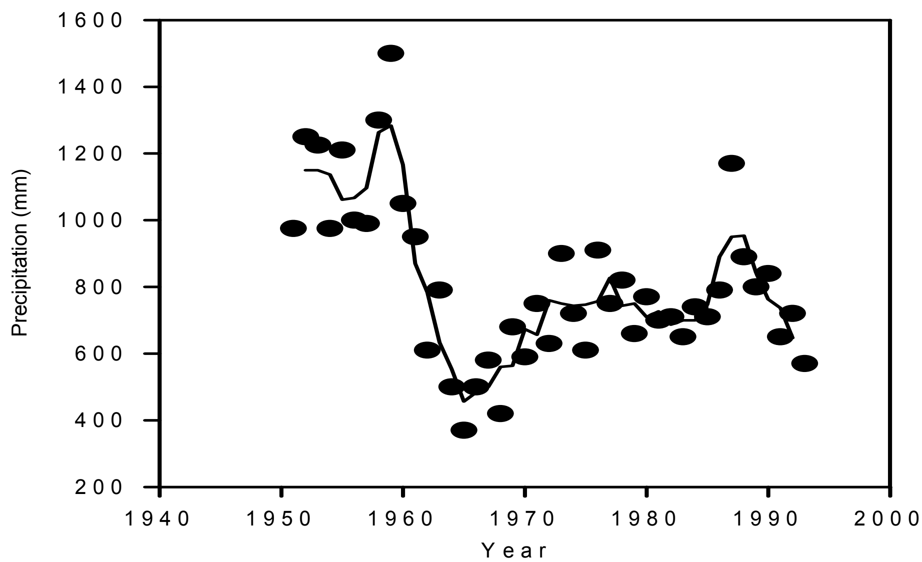




Figure 2. Increase in temperature at Marion Island (upper panel) and decline in rainfall at Kerguelen Island (lower panel) over the past half-century (from Smith & Steenkamp 1990; Frenot *et al.* 1997).

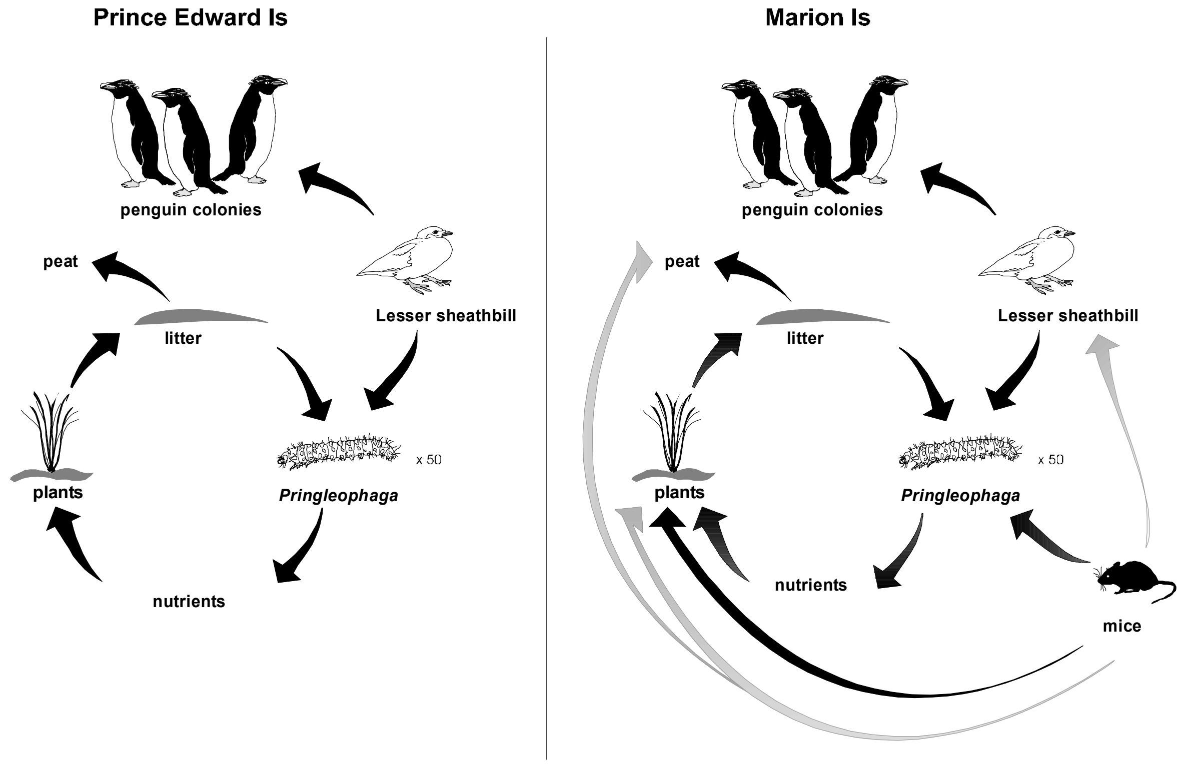



Figure 3. Schematic diagram showing interactions between plants, insects, mice and sheathbills on the Prince Edward Islands. By feeding on invertebrates and plant seeds, mice are not only directly affecting these species (dark arrows), but are also having indirect effects (light arrows) on nutrient cycling, peat accumulation and indigenous predators like the Lesser Sheathbill (*Chionis minor*).

In sum, the southern ocean islands represent ideal model ecosystems to investigate the likely effects of climate change on both terrestrial ecosystems, and the interactions between the marine and terrestrial realms (see also Kennedy 1995). Moreover, these islands also represent the only land at these positions in the southern hemisphere, and harbour significant numbers of endemic seabird and seal species, which in themselves are useful barometers of the complex southern ocean, one of the key areas influencing global climate (see Chown *et al.* 1998). The value of these islands for climate change research has been recognized explicitly by several agencies. For example, Macquarie Island has sites registered within the ITEX programme. More recently, the Scientific Committee on Antarctic Research has recognized the importance of these islands in the context of climate change and has developed an international, collaborative research programme known as Regional Sensitivity to Climate Change in Antarctic Terrestrial Ecosystems (RiSCC), that will commence in the southern summer of 2000, and that has links with the IGBP GCTE programme as well as with the DIVERSITAS initiative. Several countries have already agreed to structure their terrestrial, and parts of their marine research in accordance with RiSCC, including the Netherlands, United Kingdom, Australia, and South Africa. There is also considerable interest from the United States, Germany, New Zealand, Spain, Italy and several other nations. In South Africa, the nascent International

Long Term Ecological Research Initiative (ILTER), being set up in conjunction with the US LTER office (see Van Jaarsveld & Biggs 2000), has identified Marion Island as one of its most important, key sites.

In this proposal, support for research on, and scientific capacity development for investigating the influence of, climate change on biocomplexity at this site, in the context of these multi-national programmes, is being requested here. Not only will such support lead to the development of a greater understanding of and predictive abilities with regard to the influence of climate change on terrestrial and marine systems, but it will also substantially enhance South Africa's scientific capacity in this area, a key requirement if our commitments to the Framework Convention on Climate Change are to be met (see Van Jaarsveld *et al.* 2000).

**C. Rationale and objectives**

Climate change has been predicted to have a significant effect on species richness of ecosystems by altering energy, water availability and nutrients, the primary determinants of diversity, and secondly by altering species interactions, particularly between indigenous and invasive species, the second major determinant of diversity. The way in which such a change will occur is fundamentally a response of individuals, populations and communities to abiotic and biotic variables. To understand and to predict the form these changes are likely to take, understanding the nature of the relationships between plasticity, genetic variation, and performance will be a critical first step. These relationships will determine the abundance of species, their distributions and interactions, and ultimately, the species richness of a given site. Thus knowledge of ecosystems at many hierarchical levels, including the likely interactions between indigenous and invasive species, is required if the impacts of climate change are to be adequately predicted.

One way of examining the predicted consequences of climate change is to investigate altitudinal gradients as an analogy for future climate change. A thorough understanding of the influence of abiotic variables on individual and population performance and consequently the relationship between species abundance and species richness, and hence species interactions, across a variety of sites is likely to result in a robust model for predicting the effects of climate change.

The Prince Edward Islands, including Marion and Prince Edward Island, offer a unique opportunity to investigate the effects of global climate change on natural ecosystems. This opportunity arises because of the coincidence of several important features.

- Climate changes have been predicted to be greatest at high latitudes and have been pronounced at Marion Island over the last 50 years.
- Because of its latitudinal position, the altitudinal gradient at Marion Island is an effective mirror of Antarctic habitats: from maritime Antarctic fellfield to temperate tundra grasslands.
- Considerable changes in communities, including species richness, abundance and functions, such as performance and productivity, change along altitudinal gradients at Marion Island. In particular, there is an altitudinal gradient in complexity of communities, including a decline in the significance of invasive organisms, offering

the opportunity to construct models initially for relatively simple systems and then to extend them to higher levels of complexity.

- Many species reach the limits to their distributions along the elevational gradient, and the variety of taxa offers unique opportunities for exploring the relative roles of phenotypic plasticity and adaptation in allowing species to survive and reproduce under a range of climates.
- Marion Island has until recently (1947) been remote from direct human influence. Many communities remain in their natural form. In addition, those invasive species that are present have been well documented and most new colonizations can be recorded because of the isolation of the island from the southern continents.

Thus the Prince Edward Islands, and especially Marion Island offer a unique opportunity for investigating the impacts of climate change on biocomplexity in an integrated fashion. To do so, the following broad objectives:

**1. Determine the change in relationships between species richness and functional group diversity across the elevational gradient at Marion Island**

Species richness forms the major surrogate measure for biodiversity. It is straightforward to determine across a variety of systems. Functional groups are an additional measure of biodiversity. Across the elevational gradient the main factors influencing species richness and functional group diversity are likely to differ substantially. Historical factors provide the backdrop against which differences in temperature, water availability and nutrients are likely to influence this diversity. The significance of these latter factors, and the impact of climate change on them, form the major topic of this question, which will be addressed by investigating a variety of sites along the elevational gradient.

In addition, the relationship between species richness and functional group diversity may be important in determining a system's resilience and resistance to change. The gradient in species richness from relatively species poor and trophically simple fellfield communities to the more species rich and complex lowland, nitrophilic grasslands provides a useful tool for assessing this relationship.

To address this major research question the following issues will be investigated:

- How does species richness and functional diversity change along the gradient?

- What are the relationships between environmental factors and abundance, richness and functional diversity along the elevational gradient?

- To what extent do introduced species alter species richness, and functional diversity, and how does this change with a change in climate?

**2. Determine the nature of the responses of organisms to abiotic variables along the elevational gradient and how climate change is likely to influence these responses**

Abiotic factors such as irradiance, temperature, and water availability are important factors controlling performance of terrestrial animals. These factors vary both within and between seasons and sites, and this variation encompasses freeze/thaw and wet/dry cycles. The optimum levels of these factors and the thresholds at which the organisms are still able to function should be determined. Changes in the relationship between abiotic factors and performance will profoundly influence life histories and productivity of organisms. These relationships in turn will influence the distribution and abundance of organisms and community structure.

To provide answers to this major research question, the following issues must be addressed using selected species:

- How will climate change alter the relationship between physiological and life history traits?

- How do changes in ecosystem functioning alter the performance of top predators as climates change?

**3. Determine the extent of phenotypic plasticity, ecotypic variation and genetic variation in key indigenous and introduced species and the extent to which this might allow differential success under climate change scenarios**

Geographic isolation is a major feature of the Marion Island terrestrial environment. The extent of this isolation however is not uniform and varies across many levels. The time scales for immigration and colonization also vary from decades at lowland sites to millenia at higher elevations. The combination of different degrees of geographic isolation, time since colonisation, species biology and climatic gradients will lead to potential variation in response to climate change between species and populations. Through pre-adaptation, phenotypic plasticity or ecotypic variation species will have different capacities to absorb the effects of climate change. This variation will result in alterations to species distributions and abundances and hence will give rise to changes in community structure. The difference in plasticity or adaptability between indigenous and invasive species will in large measure determine the extent to which introduced, invasive species, alter community structure and functioning as climates change. Hence the major issues to be addressed here are:

- What is the extent of phenotypic plasticity and ecotypic variation within key species across the altitudinal gradient?

- What is the extent of genetic variation within populations of key species across sites?

- Do invasive and indigenous species differ in the extent of their genetic variation and phenotypic plasticity in a demonstrably regular way such that invasive species are likely to be more tolerant of significant climate change?

**D. Preliminary studies and institutional context**

The biota and terrestrial ecosystem of and marine system surrounding the Prince Edward Islands (comprising the larger, Marion Island and smaller, Prince Edward Island) have been the focus of biological and climatic research since the early 1950s (see Hänel & Chown 1999a for review). A substantial body of work now exists on virtually all aspects of the islands. This work covers macro- and microclimate, geology, palynology, paleoclimates and vegetation, physical and biological oceanography, single species ecological and physiological investigations, population biology, community ecology, conservation biology, invasion biology, and more recently some work on the likely impacts of climate change (see Hänel & Chown 1999b for a complete bibliography, also available at http://www.up.ac.za/academic/zoology/). Virtually all taxa have been the subject of scrutiny, although investigations of meso-arthropods are more recent (e.g. Marshall *et al.* 1999; Barendse & Chown 2001; Mercer *et al.* 2000), while investigations of micro-invertebrates are largely lacking.

As a consequence of the excellent basic research platform that has been established by scientists and logisticians at Marion Island, there is considerable scope for climate change research at the island. Much of the basic knowledge required before more sophisticated comparative and experimental work can be undertaken has been acquired. In addition, the facilities at Marion Island for the kinds of research proposed here are excellent. The island has a permanently occupied South African station that can house 64 personnel. There are four laboratories all with basic facilities and 24 h power, and the station has access to all forms of electronic communication.

The extent and quality of the research undertaken by South Africans at Marion island also means that the island has come to enjoy recognition as one of the most important natural laboratories for studying ecosystems that vary from temperate (in the lowlands) to Antarctic (at high altitudes), and for studying change in such systems. Not only does this mean that with adequate support South Africans would be in a position to continue high quality research capacity development, but also that international collaborative ventures could be developed under the auspices of SCAR and the ILTER initiative that would further expose South African researchers and research students to the international science arena. This exposure is sadly lacking in many South African institutions where past policies have stifled scientific growth.

**E. Timeframe and proposed procedure**

1. This work could be done within a minimum of five years. It is suggested that the programme have a definite cut-off date associated with a final workshop assessing findings, relevance to climate change as a whole, and the extent to which capacity development goals have been achieved.

2. The programme should be conducted within an ambit of critical peer-review to ensure that the quality of the work is internationally acceptable and that the research addresses the major goals of the programme. Redirection may be appropriate and this should be done. Flexibility is a major asset in any research program.

3. Funding for this work should be done within a two-tiered system that encourages both excellence in research and human resources development.

4. Given the requirement for sophisticated and long term science it is suggested that this programme should have a science budget of between R 500 000 for a minimum of five years, excluding logistic and administrative costs.

5. To attract students from previously disadvantaged communities, but to ensure that human resource development is not limited, a bursary scheme should be implemented that offers field biologists an amount of between R 30 000 to R 45 000 per annum. These biologists should be graduates who are aiming to complete higher degrees (preferably Ph.D.) and who are employed for the duration of the program.

## F. Key questions and research approach

Each key question identified within the context of the broad objectives necessitates a particular approach, and often these differ for different taxa, though obviously there is also a requirement for broad integration between these approaches. Thus, several Project Leaders, with expertise in different areas, will by necessity be required to participate in this programme if it is to be successfully completed. What this also means is that it is not possible to provide detailed outlines of the methods here, because different Project Leaders are likely to have somewhat different, though complimentary, approaches to the research. Rather, in this section the overall requirements and preferred approaches are indicated. Development of full proposals by each of the Project Leaders will be undertaken in the context of this document within the South African National Antarctic Programme (SANAP) system and under the auspices of the South African Committee on Antarctic Research (SACAR). However, the major difference between this proposal, and the usual SANAP process, will be that the project management team for this programme will have a central role to play in ensuring that the proposed work meets the programme objectives. The project management team will also approach research groups who have known expertise in particular areas to submit proposals. Thus, the overall Programme Leader (see Section G) will actively solicit proposals and participate in an advisory role in the review process to ensure that the proposed work meets programme goals.

### Objective 1. Determine the change in relationships between species richness and functional group diversity across the elevational gradient at Marion Island

**<u>Approach</u>**

#### KQ1.1 How do patterns of species richness and functional group diversity change with altitude?

The Marion Island terrestrial ecosystem is highly heterogeneous at low altitudes, consisting of approximately 41 plant associations that change over small spatial scales depending on the availability of nutrients, and the availability and extent of flow of water (Gremmen 1981). These communities and their basic abiotic characteristics have been categorized by Gremmen (1981) and by Smith & Steenkamp (2001). To accommodate considerable heterogeneity at low altitudes, and altitudinal change, two sampling approaches will be adopted. In the first approach, sampling for invertebrates (insects, mites, spiders, springtails, slugs, and snails) will be stratified both by major plant association and by altitude (every 100 m). In the second approach, a single vascular cushion plant species, *Azorella selago* (Apiaceae), which is known to harbour a distinct assemblage of arthropods (e.g. Barendse & Chown 2001) will be sampled in 100 m bands.

In both approaches, sampling will be quantitative, and based on core sampling and high-gradient extraction, or washing and kerosene extraction (see Barendse & Chown 2001). In the latter case the surface area of the cushion will be estimated by measuring the largest diameter and a line perpendicular to this, and using these to calculate area.

In all cases, sampling will be replicated within communities and bands based on a power analysis (see Raffaelli & Moller 2000) undertaken on currently available data (e.g. Hänel & Chown 1998; Barendse & Chown 2001; Smith & Steenkamp 2001). The altitude and spatial position of each sample will be recorded. This will ensure that spatial autocorrelation in the data (see Legendre & Fortin 1989) can be accounted for when examining altitudinal effects. Each altitudinal transect will be replicated at least twice.

The material collected will then be categorized according to several basic functional attributes. For invertebrates these will be: body size, food type (predator, herbivore, detritivore, parasitoid), reproductive mode (parthenogenetic/non-parthenogenetic), and lifestyle (euedaphic, hemiedaphic, epedaphic – see Hopkin 1997). These characterizations may have to be done for individuals at the particular altitude in several species, and where necessary this will be done. Of course, because it is well known which species have been introduced to Marion Island (see Crafford *et al.* 1986; Gremmen & Smith 1999; Gabriel 1999), it will be reasonably straightforward to take into account the effects of alien species on species richness and functional diversity along the altitudinal gradient.

**KQ1.2 What are the relationships between environmental factors and abundance, range edges, richness and functional diversity along the elevational gradient?**

Sampling for species richness, abundance, and functional diversity has been described above. To answer this question requires investigation of appropriate abiotic data at each sampling interval. Based on the work of Gremmen (1981), Smith & Steenkamp (2001), and Gabriel *et al.* (2001) it is clear that the most significant variables of interest will be: temperature (1 cm below ground), soil moisture content, soil bulk density, pH, total Na, exchangeable Na, total N, total P, $PO_4$-P, and organic carbon. At each site small temperature and humidity loggers will be installed (I-button®), and several replicate soil samples will be taken for soil chemistry analysis. Some of the variables will be recorded *in situ* on Marion Island (*e.g.*, soil moisture, pH), while the remaining variables will be recorded following sample analysis at a University-based soil analysis laboratory.

**KQ1.3 To what extent do introduced species alter species richness, and functional diversity, and how does this change with a change in climate?**

Essentially the approach here will be to investigate changes to species richness, functional group diversity and community composition that are a consequence of the inclusion of the alien species in the analyses. Mostly, this will be done in a *post hoc* fashion by excluding or including these species and examining the change in the outcomes of analyses.

Furthermore, to assess the effects of the major alien predator, the introduced house mouse, on the local ecosystem, the diet, biology, behaviour, and population density of Lesser Sheathbills on Marion Island, and if possible, on Prince Edward Island will be examined. Long-term population data are available (if somewhat patchily) on this species (see Huyser *et al.* 2000), and Burger (1982, 1984) made an in-depth study of the feeding ecology and biology of this species in the 1970s. By re-examining the diet, behaviour and biology of this species some 30 years following Burger's work, an "integrated" estimate of the effects of mice on the terrestrial system can be obtained. Lesser Sheathbills effectively integrate the impact of house mice because the birds rely on invertebrates for winter survival (Burger 1982, 1984) and because mice are thought to be having a major impact on the invertebrates (see Chown & Smith 1993) (see Fig. 3 above).

**KQ1.1 – 1.3: Analytical methods**

The four key questions within this broad objective are all closely interlinked and will be explored in combined analyses in many instances. Thus, for example, answering KQ1.2, requires information from KQ1.1. The set of key questions are very much hierarchical in this regard, and thus it makes sense to address analytical issues as a whole.

Investigations of the change in species richness and abundance (i.e. community composition) with altitude will be evaluated using a range of statistical techniques, including bivariate plots and ordinary least squares regression of species richness and other variables (e.g. total abundance) with altitude. The spatial component of this variation will also be partialled out and identified using trend surface analysis and partial regression analysis (Legendre & Legendre 1998). Differences in the communities will also be investigated using non-metric multi-dimensional scaling and analysis of similarity (see e.g. Van Rensburg *et al.* 2000). Furthermore, indicator species (McGeoch 1998) for these communities will be identified using the indicator value method (Dufrêne & Legendre 1997). These indicators will be tested across communities by comparing variability between the replicate transects.

By plotting the abundance structure of species across the altitudinal range, range edges will be identified, and the likely cause of the edges can also be identified from such abundance structure plots (Gaston & Blackburn 2000). The extent to which range edges coincide with changes in climate and soil parameters will be investigated using generalized linear models and related techniques (see McCullagh & Nelder 1998; Erasmus *et al*. 1999). Because densities ($no.m^{-2}$) will be used there will be cross-compatibility of data, even where the census technique has had to be altered because of altitudinal variation in habitat type. Nonetheless, inclusion of census area in all statistical models will allow assessment of the effects of differences in census area (Gaston *et al.* 1999).

Throughout the analyses, introduced and indigenous species will either be included explicitly as factors in the statistical model, or analyses will be undertaken separately for each group, and for the biota as a whole, to examine the extent of the influence of exotic species on patterns in species richness, functional diversity and community composition. In particular, emphasis will be given to ascertaining the extent to which species richness, abundance, and abundance structure are influenced by different abiotic variables that are likely to change as climates on the island change. For example, different responses of alien and indigenous species to temperature (see e.g.

Barendse & Chown 2000) are likely to mean that the former group of species will be favoured under a scenario of continuing temperature increases. Such a change would have profound implications for the local fauna, and is also thought to be a likely significant negative consequence of climate change in South Africa and other regions (see Van Jaarsveld *et al.* 2000, and also Smith *et al*. 2000).

For the Lesser Sheathbill work, population information that is already available will be combined with another population census and data on the feeding biology and behaviour of the species. The methods adopted by Burger (1982, 1984) in the 1970s will be used, though with some modification to allow for the application of more modern techniques.

**Objective 2. Determine the nature of the responses of organisms and communities to abiotic variables along the elevational gradient and how climate change is likely to influence these responses**

**Approach and analytical methods**

To address this objective several key species will have to be selected. In keeping with the overall commitment to interaction with the SCAR RiSCC programme, these species will be those identified in the RiSCC implementation plan, as well as species endemic to Marion Island, or significant as aliens in the local ecosystem. Among the indigenous invertebrates, the weevils *Bothrometopus parvulus*, the keystone moth, *Pringleophaga marioni* (see Klok & Chown 1997), the springtail, *Cryptopygus antarcticus*, and the *Halozetes* complex of mites (four closely related, though distinguishable species – see Marshall *et al.* 1999) will be the major candidates for further examination. Alien species are likely to include the springtails *Pogonognathellus flavescens* and *Isotomurus* sp., the slug *Deroceras caruanae*, the blowfly *Calliphora vicina*, and the moth *Plutella xylostella*.

**KQ 2.1 How will climate change alter the relationship between physiological and life history traits?**

Essentially this question concerns species replacement across the altitudinal gradient and the way in which such species replacement alters the combinations of traits found among species. The underlying rationale is that indigenous species are highly stress resistant, but have long life-cycles, low fecundity, and semelparous reproduction, or at least egg laying restricted to only a few bouts. On the other hand, alien species are predicted to be less stress resistant, with rapid life cycles, and either high fecundity, or repeated bouts of egg laying (or both) (for discussion see Crafford *et al.* 1986, Barendse & Chown 2000). In plants, very much the same situation is predicted, though fecundity relates to the quantity of viable seed produced per season (see Gremmen & Smith 1999).

The approach adopted here will be to integrate information on the life history attributes of the species concerned obtained from KQ 1.1, with detailed life history information obtained from the literature, and information on the physiological attributes of the focal species that will be made available from Objective 3. Thus, each of the major sites will act as a surrogate for a different environment (polar desert at high altitudes, to lush tussock at lower altitudes). By integrating the abiotic information (especially soil moisture and temperature) along the altitudinal gradient, with predictions of climate change at the island, and information on physiological and life history characteristics of species at the sites, predictions can be made on how climate change is likely to lead to change from one community type to another. The predictions will be made based on relationships between the variables derived from generalized linear models. Thereafter, Vensim software (http://www.vensim.com/software.html) will be used to develop a dynamic feedback model of the interactions between life history attributes, physiological variables and the abiotic environment, and to undertake sensitivity analyses thereof.

**KQ 2.2 How do changes in ecosystem functioning alter the performance of top predators as climates change??**

This is perhaps the most nebulous of all the key questions and goes to the heart of attempts to dissect the effects of species removals and additions on the characteristics of systems (Huston 1997; Tilman 1999; Rastetter et al. 1999). To address this question, information on changes in the richness, functional diversity, and community parameters (such as biomass and respiration) will be integrated from the literature with information on the past and current performance of lesser sheathbills, a species that effectively "integrates" change. This species relies on terrestrial invertebrates as a food source, and feeds at seabird colonies during the summer, and thus changes in its population structure and density can be considered a measure of overall system change. Based on these results, relationships will be sought between community respiration, species richness, functional group identity and climate (see also Reich *et al*. 1997; Wall & Virginia 1999), and changes in sheathbill populations.

**Objective 3. Determine the extent of phenotypic plasticity, ecotypic variation and genetic variation in key indigenous and introduced species and the extent to which this might allow differential success under climate change scenarios**

**<u>Approach and analytical methods</u>**

Because of the nature of this work, it would be impossible to investigate all species along the altitudinal transect. Rather, several key species will be selected and these species are among those identified for investigation under Objective 2. The species are: Insects: *Bothrometopus parvulus*, *Pringleophaga marioni*, *Calliphora vicina*, and *Plutella xylostella*, the springtails, *Cryptopygus antarcticus* and *Tullbergia bisetosa*, *Pogonognathellus flavescens* and *Isotomurus* sp. and the *Halozetes* complex of mites. If this is practicable, work will also be done on the slug *Deroceras caruanae*.

**KQ 3.1 What is the extent of phenotypic plasticity and ecotypic variation within key species across the altitudinal gradient?**

This question will be addressed by a continuation of the physiological work that formed part of Objective 2. For invertebrates, thermal tolerance (Hoffmann *et al*. 1997; Berrigan 2000), locomotory performance (Gilchrist 1996; Marshall *et al*. 1995), and development rate will be examined in at least three populations (high, low and mid-elevations).

Individuals from each of these three populations will then also be acclimated at three different temperatures, and the performance characteristics of the individuals examined at each of four different trail temperatures. This will allow estimates to be made of the extent to which phenotypic plasticity, or an acclimation response is developed within each species (see Huey *et al*. 1999; Feder *et al*. 2000; Chown 2001 for discussion).

In the springtail species, which are generally short-lived and can be reared in the laboratory, isofemale lines will also be established (see Hoffmann & Parsons 1999) so that the heritability of the traits can also be estimated (see Gilchrist 1996 for further discussion).

Analytical methods will be based on comparison of reaction norms for the various populations and acclimation treatments. Explicit statistical models for testing the adaptive significance of acclimation have been described by Huey *et al.* (1999), and the current analyses will be undertaken using these models. However, comparisons of populations will also be made using the metrics developed by Gilchrist (1996). These are optimum temperature ($T_{opt}$), maximum velocity ($u_{max}$), $T_{br}$ (= analogous to the second moment of area about a neutral axis), and the area under the performance curve.

**KQ3.2 What is the extent of genetic variation within populations of key species across sites?**

This is a straightforward phylogeographic hypothesis that must be tested. Essentially the genetic distance between populations of the selected invertebrate and plant species on Marion Island must be determined. In each case, at least 20 individuals at each of five elevations (i.e. 200 m intervals) will be sampled. For invertebrates, the cytochrome oxidase subunit I and II mitochondrial gene sequences will be determined as previously described by Bogdanowicz *et al.* (2000). Parsimony and maximum-likelihood analyses will be carried out with PAUP. Because of the high cost of the work, it is envisaged that only four invertebrate species will be examined in total. These are likely to be one of the weevil species, *Pringleophaga marioni* and two alien species.

For these taxa, a decision on the species to examine will, however, be based on the outcome of the physiological work. Clearly, if some species show no physiological variation across the altitudinal gradient, then there would be little sense in searching for genetic variation among the populations. Although an estimate of the extent of panmixis might still be interesting in such a case, it would not address the central hypothesis, which is to examine the extent to which altitudinal differences in the species have a genetic basis.

There are several good reasons for adopting this central hypothesis. The likelihood of marked phenotypic clines developing should be significant if changes in climate occur over a reasonably large geographic distance, as is the case at Marion Island. Here, the full altitudinal range of about 1000 m is realized over a geographic distance of about 11 km. In the case where phenotypic differences are found, the underlying hypothesis would be that migration from central to marginal populations declines with distance (MacArthur and Wilson 1967; Nieminen and Hanski 1998), thus resulting in marked differences between the populations (Kirkpatrick and Barton, 1997). If, however, no phenotypic differences are found, then it would seem unlikely to expect marked genetic differences.

Nonetheless, should no species show non-plastic differences in performance, then four species will still be selected to examine the extent of panmixis in the population, to verify the hypothesis set out above.

**KQ 3.3 Do invasive and indigenous species differ in the extent of their genetic variation and phenotypic plasticity in a demonstrably regular way such that invasive species are likely to be more tolerant of significant climate change?**
This question will be addressed by comparison of the data collected in KQ3.1 and KQ3.2 for alien and indigenous species. For the data collected for KQ3.1, alien and indigenous species cannot readily be compared in a formal, statistical manner. However, the protocol outlined by Pease & Fowler (1997) for partitioning variation (variance) between various influences using analysis of variance is one approach for making these kinds of comparisons, and it will be adopted here. In the case of KQ3.2 there are several formal methods that can be used to compare the alien and indigenous species. The most appropriate of these is likely to be an exploration of the distribution of mitochondrial variation using analysis of molecular variance (see Schneider *et al*. 2000).

## G. Proposed workplan, timeframe and human resources

### I. Overall institutional framework

It is proposed that this research programme runs for a five-year period. The programme has two major goals: the development of climate-change research capacity (i.e. human resources), and excellence in research output, to further our understanding of the effects of climate change on terrestrial biocomplexity. As a consequence of the fact that science awareness and education needs to be further developed in South Africa at all levels (see Blankley & Arnold 2001), part of this programme will be also concerned with improving public understanding (at all levels) of the likely impacts of climate change on South Africa's biodiversity and natural resource estates.

Because the programme has these two main goals, as well as a science awareness component, it has been structured to optimize the contributions to each component (bearing in mind that highly skilled human resource development is critical). In the context of the current situation in South Africa, there are several ways in which this optimization could have been achieved. The model chosen here is one of twinning experienced "principal" researchers with "co-researchers" who may have less experience or have previously not had access to top-level training or facilities (e.g. from some historically disadvantaged institutes) (see Chown & McGeoch 1995). To ensure that maximum training benefit is given to students from historically disadvantaged backgrounds, participation in the programme will be from B.Sc. (Hons.) level upwards.

An interdisciplinary approach forms the foundation of this programme. Therefore, the programme will require participation of several research groups, each of which will be run by a Project Leader/supervisor (see section F). Essentially, funding for several aspects of the proposal will be made available to a suite of research groups that have been identified as having the expertise to undertake the work. A Project Leader, who will have to submit a formal proposal for the work, as well as annual progress reports, will lead each of these groups. The annual reports will be peer-reviewed, and in cases of poor performance funding will be terminated (following discussion with the Project Leader), as is the case within the current SANAP. In all cases it is envisaged that the "principal researchers" under the supervision of the Project Leader/supervisor will drive the work, and the "co-researchers" will work closely with these individuals, receiving both supervision and academic mentoring from the Project Leader and Ph.D. student. In all cases, student training will form the foundation of this research programme, and the student training aspect of the programme will be structured to fit within the overall "twinning" scheme as follows:

- Ph.D. students will register at the University that is home to the Project Leader/supervisor who has been identified as most appropriate to carry out the particular research project. These Ph.D. students will be the principal researchers, and will each receive a bursary of R 45 000 per year for a maximum of three years. In the first year of the bursary scheme, the student will be awarded R 36 000 and R 9 000 will be used to purchase a desktop pc for the candidate. Selection of these students and laboratories will be based solely on research excellence and experience, though in cases of equal ability, the candidate from the disadvantaged background will be selected. All progress of students will be evaluated on a six-monthly basis, and students who do not make adequate progress will be required to leave the programme. Reports will be the responsibility of Project Leaders/supervisors and will be submitted to the Project Leader for forwarding to the programme office (see below).

- M.Sc. students will be selected on an affirmative action basis (though an Honours degree or equivalent in an appropriate field will be a minimum entrance requirement), with the understanding that if no suitable candidates apply, the position can be made available to any appropriately qualified student. These students will be the co-researchers and will each receive a bursary of R 35 000 per year for a maximum of two years. In the first year of the bursary scheme, the student will be awarded R 26 000 and R 9 000 will be used to purchase a desktop pc for the candidate, although the student can request that this amount be paid directly to them. Strict quality control will nonetheless apply in the sense that if adequate progress is not made every six months, the student will be required to leave the programme (see above). M.Sc. students will register at the University housing the laboratory that is doing the work.

- Participation by B.Sc. (Hons.) students will preferably be from their home Universities (i.e. they will remain registered there). However, the prerequisites are that their project meets the overall research goals of this programme, that they participate in the annual relief voyage to Marion Island, and that they are highly encouraged to pursue a Masters degree based on research in the programme in the years following their successful graduation. To encourage participation by historically disadvantaged candidates, a bursary of R 15 000 will be made available to each of two students, in a specified research field each year (two payments of R 7 500, with the second dependent on a satisfactory progress report). Supervisors of the students will be awarded R 5 000 to cover the student's travel expenses to Cape Town for the relief voyage, and to cover research project costs. Candidates from disadvantaged backgrounds or institutions will be given preference. In those cases where no such suitable candidates are found within a given year, the bursary will be held over for one year and will be advertised again. If there are no suitable candidates in the second year, the scheme will be opened to all students for that particular bursary.

The interdisciplinary nature of the research project means that several research teams will participate in the work, and that coordination among them will be essential. In addition, it is a pre-requisite of the Antarctic Treaty that Antarctic Treaty Consultative Parties (ATCPs – of which South Africa is one) make available research information to the broader Antarctic research community. This is also the ethos underpinning the RiSCC programme being run by the SCAR Working Group on Biology. Thus co-ordination of the research, and maintenance of a centralized metadata and data facility is essential. This kind of centralized data facility is one of the most significant and scientifically innovative features of the US LTER programme (see Van Jaarsveld & Biggs 2000). By adopting a similar approach here, results emerging from the current programme will be made accessible to the broader community, so facilitating cross system comparisons and allowing use of the data at a future time. In keeping with the policy of the Joint Committee on Antarctic Data Management (JCADM), Project Leaders will be given two years (following the termination of their funding) sole data "ownership", after which the data will be made public. Nonetheless, Project Leaders will be expected to submit metadata records and data to a centralized facility within twelve months of completion of field and/or laboratory work.

To address these requirements, as well as the science education component of the programme, it is envisaged that the programme will be supervised and coordinated by a project management team, operating in close collaboration with DEA&T, from a central scientific office. The office will be staffed by the Programme Leader, and a full time research coordinator/data manager, who will also be responsible for promoting the programme to the public. The tasks of each of these personnel will be as follows:

- **Programme Leader:** scientific coordination of the programme; liaison with all Project Leaders; liaison with DEA&T logistics at the planning level; facilitation of interaction and networking with other climate change programmes and with the SCAR RiSCC programme; preparation of annual reports; hosting and chairing science planning meetings and workshops; final selection, with the principal researchers and an external assessor, and based on reviewers comments, of students for the programme; completion of an annual "internal" science audit; ensuring that the annual financial audit is prepared for and undertaken by the institutional finances department and external auditors, respectively.

- **Research Coordinator and Data Manager:** on-the-ground liaison with logistics; organizing and running science planning meetings and workshops; maintenance of a list server to ensure inter-project communication; metadata and data archiving in conjunction with the Joint Committee for Antarctic Data Management of SCAR and COMNAP, and the RiSCC central database operated by the Australian Antarctic Datacentre; facilitation and coordination of interdisciplinary data analysis projects; negotiating and facilitating access to, and making available electronically, past data collected at Marion Island; facilitating access by participants in this programme to data collected by other researchers who are part of the RiSCC programme; administration of student selection procedure and annual reporting scheme; guidance of B.Sc. (Hons.) students at Marion Island each year; liaison with media concerning the programme; dissemination at schools, public fora (e.g. science fests), and tertiary institutions of information on climate change and its impacts in South Africa and in the Antarctic region; provision of appropriate, current information for the programme homepage.

**II. Workplan, timeframe and human resources**

Each of the three broad research objectives requires participation by a suite of researchers specializing in the particular field, and integration of the research results at the end of the programme. Clearly, budgetary constraints mean that all aspects of the work cannot run simultaneously. Thus, the workplan and human resources development scheme set out below have been developed to accommodate these requirements. Once again, because the specifics of the research approach will be left to the appropriate Project Leaders, only a general workplan has been developed here, the details of which must be fleshed out by the Project Leaders and researchers.

To facilitate identification of principal researchers and co-researchers, upper and lower case letters distinguish them, respectively. The letters remain constant for individuals and indicate the career path of the researcher for the duration of the programme. It is presumed that if this programme goes ahead, there will be some flexibility to use funds in advance of the first year to advertise crucial posts and to set up the central office. Because the Marion Island relief takes place in April each year, it is considered essential that contract staff commence work in early January of the first year of the programme (or sooner if this is possible).

**Lead-in to First Year (2001)**

1. Central office established. Programme leader in conjunction with DEA&T advertises for Research Coordinator and Graduate Student Coordinator.
2. Project leaders in animal ecology (specifically ecology of Lesser Sheathbills), animal molecular population biology, and science awareness are approached and asked to submit detailed proposals. A summary version of this proposal is made available to the project leaders electronically.
3. Advertisements by Internet via the National Research Foundation and scientific societies for graduate students in invertebrate ecophysiology and plant ecology are placed.
4. Advertisements by Internet via the National Research Foundation and scientific societies for graduate students in molecular systematics are placed.
5. Advertisements by Internet via the National Research Foundation and scientific societies for B.Sc. (Hons.) supervisors and students in insect ecology and science awareness are placed.
6. B.Sc. (Hons.) proposals received by no later than 31$^{st}$ January 2002
7. Science proposals received by 15$^{th}$ February 2002.

**First Year (2002)**

<u>General workplan</u>

1. The central office is opened.
2. Database and communication facilities established. Home page for programme established. Internet database links with RiSCC and other programmes made.
3. Outcome of science review process made known to all applicants by 28th February 2002.
4. Following submission of proposal, the invertebrate ecophysiology is undertaken by the Programme Leader also acting as Project Leader in this instance.
5. Funds transferred for invertebrate ecophysiology work, and for animal molecular systematics.
6. B.Sc. (Hons.) awards made known by 28th February, and funds transferred to appropriate institutions.
7. Student interviews undertaken.
8. Research work commences during April 2002 relief.
9. Berths for the relief (S.A. Agulhas and Marion Base) for two Project Leaders, the education coordinator, and six students (A + a + B + b + d + e) are required.
10. Accommodation for four research students for the full year at Marion Island is required.
11. Central office receives and processes reports.
12. Research coordinator travels to two major centers in South Africa to discuss programme and develop science awareness.
13. Production of posters and pamphlets advertising the programme.
14. Audited statements submitted.
15. Annual science review undertaken.
16. Advertisements by Internet via the National Research Foundation and scientific societies for B.Sc. (Hons.) supervisors and students in molecular biology and animal ecology are placed.
17. B.Sc. (Hons.) proposals received by no later than 30th November.
18. Research coordinator travels to Australian Antarctic Division to for discussions with and to receive advice from Antarctic Data Centre. (OUTSIDE FUNDING SOUGHT FOR THIS)

<u>Human resources</u>

| | |
|---|---|
| Programme Leader: | Also Project Leader 1 for invertebrate work. |
| Research Coordinator | |
| Project Leader 2: | Molecular Systematics |
| Invertebrate Ecophysiology: | Fieldwork involving students A + a. |
| Molecular Systematics: | Field- and lab.-work involving students B + b. |
| Plant Ecology: | Hons student d: home-based, Marion 1 month. |
| Science Awareness: | Hons student e: home-based, Marion 1 month. |

**Second Year (2003)**

General workplan

1. Invertebrate ecophysiology and animal molecular systematic work continues. Funds transferred for continuation based on progress reports.
2. Plant ecology work commences. Funds transferred for this purpose.
3. B.Sc. (Hons.) awards made known by 30th January, and funds transferred to appropriate institutions.
4. Student interviews undertaken.
5. Berths for the relief (S.A. Agulhas and Marion Base) for three Project Leaders, the research coordinator, and eight students are required during the annual relief (four students traveling down (d + e + f + g), six students returning A + a + B + b + f + g).
6. Accommodation for two research students for the full year at Marion Island is required.
7. Students a, b, complete and submit Masters theses and publications by year-end.
8. Central office receives and processes reports.
9. Research coordinator travels to one major center in South Africa to discuss programme and develop science awareness.
10. Audited statements submitted.
11. Annual science review undertaken.
12. Advertisements by Internet via the National Research Foundation and scientific societies for B.Sc. (Hons.) supervisors and students in animal ecology are placed.
13. B.Sc. (Hons.) proposals received by no later than 30th November.

Human resources

| | |
|---|---|
| Programme Leader: | Also Project Leader 1 for invertebrate work. |
| Research Coordinator | |
| Education Coordinator | |
| Project Leader 2: | Molecular Systematics |
| Project Leader 3: | Plant Ecology |
| Project Leader 4: | Science Awareness. |
| Invertebrate Ecophysiology: | Write-up students A + a. |
| Molecular Systematics: | Lab-work and write-up student B, write-up student b |
| Plant Ecology: | Fieldwork involving student d. |
| Science Awareness: | Field-based work involving student e. |
| Animal Ecology: | Hons students f, g: home-based, Marion 1 month. |

**Third Year (2004)**

General workplan

1. Invertebrate ecophysiology, molecular systematics, and plant ecology work continues. Funds transferred for continuation based on progress reports.
2. Invertebrate ecology work commences with students G + g.
3. Students A and B complete Ph.D. theses and publications by year-end.

4. Students d + e complete M.Sc. theses and publications by year-end.
5. B.Sc. (Hons.) awards made known by 30th January, and funds transferred to appropriate institutions.
6. Student interviews undertaken.
7. Berths for the relief (S.A. Agulhas and Marion Base) for two Project Leaders, the research coordinator, and seven students are required during the annual relief (five students traveling down (A + G + g + h + i), five students returning (A + d + e + h + i)).
8. Accommodation for two research students for the year is required.
9. Central office receives and processes reports.
10. Research coordinator travels to two major centers in South Africa to discuss programme and develop science awareness.
11. Audited statements submitted.
12. Annual science review undertaken.
13. Workshop on programme progress and proposed changes undertaken at central office.
14. Advertisements by Internet via the National Research Foundation and scientific societies for B.Sc. (Hons.) supervisors and students in animal ecology and science awareness are placed.
15. B.Sc. (Hons.) proposals received by no later than 30th November.

<u>Human resources</u>

| | |
|---|---|
| Programme Leader: | Also Project Leader 1 for invertebrate work. |
| Research Coordinator | |
| Project Leader 2: | Molecular Systematics. |
| Project Leader 3: | Plant Ecology. |
| Project Leader 4: | Science Awareness. |
| Project Leader 5: | Invertebrate Ecology. |
| Invertebrate Ecophysioloy: | Write-up involving student A. |
| Molecular Systematics: | Write-up involving student B. |
| Plant Ecology: | Write-up involving student d. |
| Science Awareness: | Write-up involving student e. |
| Invertebrate Ecology: | Field- and lab. work, students G + g |
| Animal Ecology: | Hons students h, i: home-based, Marion 1 month. |

**Fourth Year (2005)**

<u>General workplan</u>

1. Final reports for molecular systematics, invertebrate ecophysiology, and plant ecology received by 31st January, and sent out for review.
2. Invertebrate ecology work continues. Funds transferred for continuation based on progress reports.
3. Sheathbill ecology work commences and funds transferred for this purpose.
4. Student g completes M.Sc. thesis and publications by year-end.
5. B.Sc. (Hons.) awards made known by 30th January, and funds transferred to appropriate institutions.

6. Student interviews undertaken.
7. Berths for the relief (S.A. Agulhas and Marion Base) for two Project Leaders, the research coordinator, and six students are required during the annual relief (four students traveling down (h + i + k + l), four students returning (G + g + k + l)).
8. Accommodation for two research students for the full year at Marion Island is required.
9. Central office receives and processes reports.
10. Research coordinator travels to two major centers in South Africa to discuss programme and develop science awareness.
11. Audited statements submitted.
12. Annual science review undertaken.
13. Advertisement by Internet via the National Research Foundation and scientific societies for B.Sc. (Hons.) supervisor and student in science awareness is placed.
14. B.Sc. (Hons.) proposals received by no later than 30th November.

<u>Human resources</u>

| | |
|---|---|
| Programme Leader: | Invertebrate project completed. |
| Research Coordinator | |
| Project Leader 2: | Molecular Systematics – on list, but project completed. |
| Project Leader 3: | Plant Ecology – on mailing list, but project completed. |
| Project Leader 4: | Science Awareness – on list, but project completed. |
| Project Leader 5: | Invertebrate Ecology. |
| Project Leader 6: | Avian Ecology. |
| Invertebrate Ecology: | Write-up involving students G + g. |
| Avian Ecology: | Fieldwork, students h + i |
| Animal Ecology: | Hons. student k, home-based, Marion 1 month. |
| Science Awareness: | Hons. student l, home-based, Marion 1 month. |

**Final Year (2006)**

<u>General workplan</u>

1. Draft final reports for all projects received by 30th November and sent out for review.
2. Invertebrate ecology and sheathbill (avian) ecology continues. Funds transferred for continuation based on progress reports.
3. Student G completes Ph.D. thesis and publications by year-end.
4. Students h + i complete M.Sc. theses and publications by year-end.
5. B.Sc. (Hons.) award made known by 30th January, and funds transferred to appropriate institutions.
6. Berths for the relief (S.A. Agulhas and Marion Base) for one Project Leader, the research coordinator, and three students are required during the annual relief (one traveling down (n), three students returning (h + i + n)).
7. Accommodation not required for research students.
8. Central office receives and processes reports.
9. Research coordinator travels to one major center in South Africa to discuss programme and develop science awareness.

10. Audited statements submitted.
11. Project science review undertaken.
12. Wrap-up workshop held for all Project Leaders and an additional eight to ten participants at Central Office.
13. Data deposited at DEA&T.
14. Database handed over to DEA&T.
15. Outstanding data from Project Leaders solicited via agreement to provide data within two-year period.
16. Central Office closed down, equipment distributed according to DEA&T policy.

<u>Human resources</u>

| | |
|---|---|
| Programme Leader: | |
| Research Coordinator | |
| Education Coordinator | |
| Project Leader 2: | Molecular Systematics – on list, but project completed. |
| Project Leader 3: | Plant Ecology – on mailing list, but project completed. |
| Project Leader 4: | Science Awareness – on list, but project completed. |
| Project Leader 5: | Invertebrate Ecology. |
| Project Leader 6: | Avian Ecology. |
| Invertebrate Ecology: | Write-up involving student G. |
| Avian Ecology: | Fieldwork and write-up, students h + i |
| Science Awareness: | Hons. student n, home-based, Marion 1 month. |

**Follow-upYear (2007)**

Final programme overview submitted by year-end.

**H. Budget**

The budget set out below makes several fundamental assumptions. First, it is assumed that the South African economy will hold its own for the next five years. This is an optimistic assumption, but the extent to which it might change in a negative direction is difficult to predict. Nonetheless, it should be borne in mind that if the economy does worsen substantially from a global perspective, then either support for the final years of the work will have to be increased, or some of the work will have to be cut. The budget has been designed with some leeway for a potential decline in the value of the South African currency, but the scope for this is not large.

Second, the budget has not been set out to provide line item costs for running expenses. It has been assumed, based on current experience, and advice from several researchers, that a student in ecology costs about R 14 000 - 15 000 in running expenses, that this cost for a physiologist is R 18000 - 20 000, and that for a molecular population biologist the cost is about R 35 000. Line item budgets generally come reasonably close to this amount.

Third, if Project Leaders require capital equipment items and can reasonably justify purchasing them on their budgets without compromising other parts of the work, then this should be allowed. For example, Project Leaders might find it useful for each student to have access to a GPS, rather than to share one between them.

Fourth, it is assumed that Project Leaders will use the current funding as a means to leverage funding from other agencies too. For example, a programme of this nature might easily approach the National Research Foundation's Science Liaison Secretariat for funding international travel of Project Leaders to other laboratories, or prominent foreign researchers to travel to South Africa.

Fifth, generous bursaries and salaries have been made available to attract top-level personnel and to ensure that they remain committed to the programme.

**I. Overall budget summary (ZAR)**

| ITEM | 2002 | 2003 | 2004 | 2005 | 2006 | Total |
|---|---|---|---|---|---|---|
| Ph.D. Bursaries | 90000 | 90000 | 135000 | 45000 | 45000 | **405000** |
| M.Sc. Bursaries | 70000 | 140000 | 105000 | 105000 | 70000 | **490000** |
| Hons. Bursaries | 30000 | 30000 | 30000 | 30000 | 15000 | **135000** |
| Research coordinator | 100000 | 100000 | 100000 | 100000 | 100000 | **500000** |
| **Salary Subtotal** | **290000** | **360000** | **370000** | **280000** | **230000** | **1530000** |
| Running costs | 140000 | 155000 | 135000 | 80000 | 95000 | **605000** |
| Hons. supervisor running cost | 10000 | 10000 | 10000 | 10000 | 5000 | **45000** |
| Travel and workshop costs | 53400 | 40850 | 51100 | 43700 | 62900 | **251950** |
| **Running Subtotal** | **203400** | **205850** | **196100** | **133700** | **162900** | **901950** |
| **Equipment Subtotal** | **68000** | **0** | **0** | **0** | **0** | **68000** |
| | | | | | | |
| **Grand Total** | **561400** | **565850** | **566100** | **413700** | **392900** | **2499950** |

**II. Running expenses breakdown**

| Item/Year | Student Costs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **2002** | **Ecol. No.** | **Ecol. cost** | **Physiol. No.** | **Physiol. Cost** | **Molec. No.** | **Molec. Cost** | **Item Cost** | **Total cost** |
| Student running | 0 | 17000 | 2 | 25000 | 2 | 35000 | | 120000 |
| Central office | | | | | | | 14000 | 14000 |
| Advertising | | | | | | | 6000 | 6000 |
| **TOTAL** | | | | | | | | **140000** |
| | | | | | | | | |
| **2003** | **Ecol. No.** | **Ecol. cost** | **Physiol. No.** | **Physiol. Cost** | **Molec. No.** | **Molec. Cost** | **Item Cost** | **Total cost** |
| Student running | 2 | 15000 | 2 | 20000 | 2 | 35000 | | 140000 |
| Central office | | | | | | | 15000 | 15000 |
| **TOTAL** | | | | | | | | **155000** |
| | | | | | | | | |
| **2004** | **Ecol. No.** | **Ecol. cost** | **Physiol. No.** | **Physiol. Cost** | **Molec. No.** | **Molec. Cost** | **Item Cost** | **Total cost** |
| Student running | 4 | 15000 | 1 | 20000 | 1 | 35000 | | 115000 |
| Central office | | | | | | | 20000 | 20000 |
| **TOTAL** | | | | | | | | **135000** |
| | | | | | | | | |
| **2005** | **Ecol. No.** | **Ecol. cost** | **Physiol. No.** | **Physiol. Cost** | **Molec. No.** | **Molec. Cost** | **Item Cost** | **Total cost** |
| Student running | 4 | 15000 | 0 | 20000 | 0 | 35000 | | 60000 |
| Central office | | | | | | | 20000 | 20000 |
| **TOTAL** | | | | | | | | **80000** |
| | | | | | | | | |
| **2006** | **Ecol. No.** | **Ecol. cost** | **Physiol. No.** | **Physiol. Cost** | **Molec. No.** | **Molec. Cost** | **Item Cost** | **Total cost** |
| Student running | 3 | 15000 | 0 | 18000 | 0 | 23000 | | 45000 |
| Central office | | | | | | | 20000 | 20000 |
| Publications | | | | | | | 30000 | 30000 |
| **TOTAL** | | | | | | | | **95000** |
| | | | | | | | | |
| **Note: Science awareness Masters student has running costs included with ecologists** | | | | | | | | |

**Notes**:

1. The central office running expenses are for telephones, faxes, postage, Internet access, homepage design, implementation and updates, and running of the reporting scheme.

2. Advertising costs are for advertising the research coordinator and education coordinator posts.

3. Running costs per student include R 3000 for medical insurance per year.

## III. Travel and workshops

| Item/Year | People No. | Flights | | | Daily costs: Accommodation and car rental, etc. | | | |
|---|---|---|---|---|---|---|---|---|
| **Item/Year** | **People No.** | **Airfare** | **Ret. Flights** | **AF Total** | **Cost** | **Days** | **Total** | **Item Total** |
| **2002** | | | | | | | | |
| Student travel, interviews | 4 | 2500 | 1 | 10000 | 350 | 2 | 2800 | 12800 |
| Student travel, relief | 6 | 2500 | 1 | 15000 | 350 | 4 | 8400 | 23400 |
| Project leaders, relief | 2 | 2500 | 1 | 5000 | 350 | 4 | 2800 | 7800 |
| Education coordinator | 1 | 2500 | 1 | 2500 | 350 | 12 | 4200 | 6700 |
| Car Hire (EC) | 1 | | | | 150 | 10 | 1500 | 1500 |
| Car hire (students & leaders in CT) | 2 | | | | 150 | 4 | 1200 | 1200 |
| **TOTAL** | | | | | | | | **53400** |
| | | | | | | | | |
| **2003** | **People No.** | **Airfare** | **Ret. Flights** | **AF Total** | **Cost** | **Days** | **Total** | **Item Total** |
| Student travel, interviews | 1 | 2500 | 1 | 2500 | 350 | 2 | 700 | 3200 |
| Student travel, relief | 6 | 2500 | 1 | 15000 | 350 | 4 | 8400 | 23400 |
| Project leaders, relief | 2 | 2500 | 1 | 5000 | 350 | 4 | 2800 | 7800 |
| Education coordinator | 1 | 2500 | 1 | 2500 | 350 | 7 | 2450 | 4950 |
| Car Hire (EC) | 1 | | | | 150 | 6 | 900 | 900 |
| Car hire (students & leaders in CT) | 1 | | | | 150 | 4 | 600 | 600 |
| **TOTAL** | | | | | | | | **40850** |
| | | | | | | | | |
| **2004** | **People No.** | **Airfare** | **Ret. Flights** | **AF Total** | **Cost** | **Days** | **Total** | **Item Total** |
| Student travel, interviews | 2 | 2500 | 1 | 5000 | 400 | 2 | 1600 | 6600 |
| Student travel, relief | 3 | 2500 | 1 | 7500 | 400 | 4 | 4800 | 12300 |
| Project leaders, workshop | 2 | 2500 | 1 | 5000 | 400 | 2 | 1600 | 6600 |
| Project leaders, relief | 2 | 2500 | 1 | 5000 | 400 | 4 | 3200 | 8200 |
| Education coordinator | 1 | 2500 | 2 | 5000 | 400 | 14 | 5600 | 10600 |
| Car Hire (EC) | 1 | | | | 200 | 14 | 2800 | 2800 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Car hire (students & leaders in CT) | 2 | | | | 200 | 4 | 1600 | 1600 |
| Catering 2 days | 4 | | | | 300 | 2 | 2400 | 2400 |
| **TOTAL** | | | | | | | | **51100** |
| | | | | | | | | |
| **2005** | **People No.** | **Airfare** | **Ret. Flights** | **AF Total** | **Cost** | **Days** | **Total** | **Item Total** |
| Student travel, interviews | 0 | 2500 | 1 | 0 | 400 | 2 | 0 | 0 |
| Student travel, relief | 5 | 2500 | 1 | 12500 | 400 | 4 | 8000 | 20500 |
| Project leaders, relief | 2 | 2500 | 1 | 5000 | 400 | 4 | 3200 | 8200 |
| Education coordinator | 1 | 2500 | 2 | 5000 | 400 | 14 | 5600 | 10600 |
| Car Hire (EC) | 1 | | | | 200 | 14 | 2800 | 2800 |
| Car hire (students & leaders in CT) | 2 | | | | 200 | 4 | 1600 | 1600 |
| **TOTAL** | | | | | | | | **43700** |
| | | | | | | | | |
| **2006** | **People No.** | **Airfare** | **Ret. Flights** | **AF Total** | **Cost** | **Days** | **Total** | **Item Total** |
| Student travel, interviews | 0 | 2500 | 1 | 0 | 500 | 2 | 0 | 0 |
| Student travel, relief | 3 | 2500 | 1 | 7500 | 500 | 4 | 6000 | 13500 |
| Project leaders, workshop | 8 | 2500 | 1 | 20000 | 500 | 2 | 8000 | 28000 |
| Project leaders, relief | 1 | 2500 | 1 | 2500 | 500 | 4 | 2000 | 4500 |
| Education coordinator | 1 | 2500 | 1 | 2500 | 500 | 7 | 3500 | 6000 |
| Car Hire (EC) | 1 | | | 0 | 300 | 7 | 2100 | 2100 |
| Car hire (students & leaders in CT) | 1 | | | 0 | 200 | 4 | 800 | 800 |
| Catering 2 days | 10 | | | 0 | 400 | 2 | 8000 | 8000 |
| **TOTAL** | | | | | | | | **62900** |

## IV. Equipment

| Equipment | 2002 |
|---|---|
| 2 x HG extractors | 30000 |
| 1 x HP Laserjet printer | 6000 |
| 1 x desktop pc incl. cd writer | 10000 |
| 1 x ACER 525 Notebook pc | 20000 |
| 1 x Garmin GPS | 2000 |
| **Annual Total** | **68000** |

**Notes:**

1. The availability of the substantial infrastructure available in the Botany/Entomology Laboratory and Wet Laboratory at Marion Island is assumed here. This infrastructure includes 24 h power, bench space, sinks, drying ovens, water distiller, controlled temperature cabinets, fume cabinets, and electronic microbalances.

2. The physiological instrumentation required will be loaned from DEA&T's central store of such equipment.

3. The miniature I-button loggers will be purchased with other funding. Thus, although mentioned in the proposal they are not included here.

4. The High Gradient extractors are used for extraction of invertebrates from soil cores. The extractors have been field tested at Marion Island and perform very well (e.g. Barendse & Chown 2001).

5. The desktop pc and printer is for running the central office. The notebook pc will facilitate data capture and management by the research coordinator.

6. Because spatial analysis is a key component of this research programme, Geographic Positioning Systems (GPS) will be essential. One will be purchased for the ecology components of the programme, though collection localities will be documented by all groups. Other GPS could be purchased by the project leaders.

7. The equipment listed here is essential for the programme. There is no real way that the sampling work could be done without the dedicated equipment, and the office equipment is essential for management of the project.

## I. Scientific review procedure

A large, interdisciplinary programme such as the one proposed here depends for its success on careful project management and regular review of progress. In Section G of the proposal, the composition and roles of the project management team have been set out. To ensure that they are succeeding in their tasks, that the programme is being rolled out according to the way it has been planned, and that the various projects are undertaking their work in a productive and timely fashion, regular review is required.

Rather than set out specific milestones here (these have been broadly outlined in Section G in any case), the idea is to provide an outline of the review process and structures that will be employed.

**Review process**

As with all relatively large programmes, a suitable balance between regular review and over-reporting must be achieved. To do so, a straightforward two-tiered review process will be adopted.

The first tier will consist of review of the overall programme. An external assessors, appointed to review progress of the programme as a whole, will undertake this review every year, based on the annual report produced by the project management team with the assistance of the Project Leaders. At the end of the five-year period it is envisaged that these assessors review the entire programme based on its outputs, and presentations at the closing workshop. It is envisaged that the reviewer will be drawn from the biological research communities in the U.S.A./U.K., and will have some experience of Antarctic research. The commitment of the reviewer to this process will depend on the project management team's ability to solicit additional funding for this component.

The second review tier will encompass review of the project proposals themselves. These proposals will be those submitted by Project leaders of external groups that will participate in the research. The Programme Leader in conjunction with the South African Committee on Antarctic Research will coordinate review of these proposals, while external referees will undertake the reviews. Review of progress will be undertaken on an annual basis.

**Review structures**

Both the first and second tier reviews will be managed by the project management team with the assistance of the South African Committee on Antarctic Research (SACAR). It is also envisaged that SACAR will appoint, on at least two occasions, external assessors of their own choice to provide an audit both of the programme and of the review process.

## J. Sample and data storage

The SANAP policy will be followed here. Voucher specimens of all species should be made available to national and international institutions. All projects will be required to provide metadata records to the Antarctic Master Directory, and data will have to be lodged with the project database within one year of its collection. In some instances these data will be lodged in international databases (e.g. GenBank for gene sequences), and links via a metadata record will be required. On conclusion of this programme, the database that has been developed will be handed over to SANAP or to an agency approved by them. South Africa has several large-scale database initiatives for biological data, of which the South African Integrated Spatial Information System (**http://www.geospace.co.za/Isis**) is perhaps the most well developed.

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## ANNEX D. Student and Supervisor Contract

**AGREEMENT:**
**POSTGRADUATE POSITION WITHIN THE CLIMATE CHANGE CAPACITY BUILDING PROGRAMME RUN BY STELLENBOSCH UNIVERSITY**

A. I, the undersigned,…………………………………………………………(full name AND ID), in the Department / Institute of……………………………………………………………….. at the University of ………………………………………………………………………………. (hereafter the Home Institution), hereby (i) accept the Fellowship awarded to me for post-graduate within the Stellenbosch University (SU)/Department of Environmental Affairs & Tourism (DEAT)/US Agency for International Development (USAID) Climate Change Capacity Building Programme (hereafter the CCBP) and (ii) unconditionally undertake the following:

1. At the end of my stay, (i) all research materials - including for example microbial cultures, original laboratory books, laboratory protocols established during my stay, the photographic materials involved and the computer hardware and software involved - and (ii) any other property of the Home Institution shall be left in the care of the supervisor or host.
2. Unless both parties to this Agreement agree otherwise in a subsequent written document, any research material which arose directly from the research conducted by me at the Home Institution shall remain the property of the Home Institution. Furthermore I hereby undertake not to transfer any such material to any third party without prior consent in writing by the Home Institution, SU, and the supervisor.
3. If any intellectual property rights in and to any invention, patent or know-how arise as a direct consequence of my research involvement at the Home Institution, all such rights shall vest in the Home Institution.
4. No work conducted by me in a laboratory of the Home Institution shall be published without the supervisor’s or postdoctoral host’s prior consent in writing. Any publication arising from research conducted by me at the Home Institution shall appear under the address of the Home Institution and shall expressly acknowledge both the SU and the SU/DEAT/USAID CCBP.
5. In the event of my leaving the Home Institution before the expiry of the contract period, the following conditions shall apply:
   i) Departure within the first three months: funds granted by the SU/DEAT/USAID CCBP as a bursary, honorarium, salary or “personal establishment” funds shall be refunded by me in full on request;
   ii) Departure in the period after the first three months but within the first six months (B.Sc. (Hons) or year (M.Sc./Ph.D.): 50% of the funds granted by the SU/DEAT/USAID CCBP as a bursary, honorarium or salary or as “personal establishment” funds shall be refunded by me on request.
   iii) Departure in the period after the first year (for Masters and Ph.D. students) but before successful completion of the degree programme (all students): 30% of the funds granted by the SU/DEAT/USAID CCBP as a bursary, honorarium or salary or as “personal establishment” funds shall be refunded by me on request.

B The Home Institution or SU hereby undertakes as follows: Results shall not be published without consultation with me about appropriate acknowledgement of (i) authorship and/or (ii) research contributions made by me as the postgraduate student undersigned.

C. The parties undersigned hereby agree that the conditions of this Agreement shall remain effective unless modified in a subsequent written document signed by the parties.

D. I hereby elect the following residential address as my *domicilium citandi et executandi* for the service of any notice and for any court process in terms of this Agreement:

…………………………………….
…………………………………….
…………………………………….
NOTE:*(PO Box numbers and university addresses are not acceptable for this purpose. Please, therefore, state a **residential** address.)*

E Special terms and condition:

1 Bursary amount shall be limited to R15 000 per annum (B.Sc. Hons), R35 000 per annum (M.Sc.), or R 45 000 per annum (Ph.D.), subject to the annual renewal at the sole discretion of SU/DEAT/CCBP, who may also change the value of the bursary at such time.
2 Bursaries shall be paid directly into the account of the postgraduate student in two payments. The second payment shall occur subject to the submission of a satisfactory progress report (M.Sc. and Ph.D.) or a 50% pass rate during the June /July examination (B.Sc. Hons.). and shall be paid in the first week of the second semester.
3 All consultation work done by student shall be subject to permission from the Home Institution to prevent academic goals being neglected in the process
4 A bursary for PhD studies shall not be awarded for more than three years, for a M.Sc. study the bursary shall only be awarded for two years, and for a B.Sc. (Hons.) study the bursary shall only be awarded for one year.
5 Should the student no longer qualify for the bursary owing to unsatisfactory progress and/or Departure from the Home Institution, the Home Institution shall no longer qualify for running expenses for the project, shall have to submit an audited statement of closure of the account within two months, and shall have to return unspent funds to the SU/DEAT/USAID CCBP within two months after acceptance by the SU/DEAT/USAID CCBP of the Home Institution's audited statement.

**Accepted and signed at ....... .................. this ......….. day of ..........................200**

...................................................................... ......................................................................
Postgraduate student Supervisor

………………………………………………
University Administration Representative

…………………………………………..
For and on behalf of the SU

......................................................................

**ANNEX E. Conditions of Award of Hons. Bursaries**

Spatial, Physiological and
Conservation Ecology Group
Direct Tel: +2721 808 2385
E-mail: slchown@sun.ac.za

XXXXXXXXXXXXXXXX
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XXXXX

XX March 2002

Dear Dr. X

**USAID/DEA&T/U. STELLENBOSCH CLIMATE CHANGE CAPACITY BUILDING PROGRAMME**

*Apropos* our conversations regarding the possibility of your student's participation in this project I would like to provide you with additional information regarding the Programme requirements and what we can offer.

1. The programme is a collaborative programme between the University of Stellenbosch and the South African Department of Environmental Affairs & Tourism, funded by the United States Agency for International Development. I am responsible for overall project management and will be assisted by Mr. Richard Mercer who will run the Central Office at the University of Stellenbosch. As part of this programme we are at liberty to engage expertise from elsewhere to assist with this work. Hence this letter.

2. We can provide you with a single bursary for an Hons level student (R 15000) with R 5000 running costs. These amounts can either be transferred to yourself and you will be responsible for submitting an audited statement of expenditure to us, or we can process all financial administration from here. Running expenses cover any legitimate expense. Student travel within South Africa to and from Cape Town will be covered independently by the Central Office, as will you, or your representative's travel for the relief.

3. The South African National Antarctic Programme will cover all costs of travel to and from the Prince Edward Islands, subsistence on Marion Island, and protective clothing at the island, subject to their usual terms and conditions.

4. The student's work must concern any aspect of the terrestrial ecology of invertebrates at Marion Island. Participation in the relief voyage is a pre-requisite.

5. The student must be from previously disadvantaged population group (black, coloured, Asian), and must be a South African citizen.

6. Both yourself and the student will be required to sign an agreement with the University of Stellenbosch, countersigned by your Institution's administration or your HOD, indicating that if the student leaves the project within three months of its inception, the full bursary amount and the unspent remaining running expenses will be returned to the University of Stellenbosch; that if this occurs after six months, 50% of the bursary and all remaining running costs must be returned, and if the student does not graduate, 30% of the bursary and all unspent running expenses must be returned. This agreement will also specify that DEA&T, USAID, and the University of Stellenbosch must be acknowledged for support in all products of the research. If funds are administered from here then only the student bursary amount is at issue.

7. The Intellectual Property Rights and data ownership will remain yours, with the understanding that all work must be submitted to the Central Office for archiving within six months of completion of the project, and that this work can be released for public use five years after completion of the project. In this respect, the Central Office will undertake not to release any of your work without your express permission within the first six years after commencement of your project, and will notify you of requests for your work following that so long as the Central Office remains operational. On closure of the Central Office all work in the archive will revert to the DEA&T. This arrangement is in keeping with the provisions of the Antarctic Treaty, which the DEA&T apply to all of the research they fund in the Southern Ocean and Antarctic regions.

8. You will be required to submit an interim progress report, including no more than one A4 page providing details of project progress, and a copy of provisional transcripts (i.e. marks for Hons. Exams completed by end July 2002), which will ensure release of the second half of the student's bursary (there will be two payments – one in March 2002 and one in August 2002 pending a satisfactory progress report). A final report must be submitted on completion of the project. This must include the student's project, as well as hard and electronic copies of all data collected. The report should follow the Directorate Antarctica & Islands reporting format, but should be submitted electronically. Both you and your Institution's appropriate authority (H.O.D. is fine) should sign a covering letter and send this as a hard copy. If funds are transferred to you, then the report must be accompanied by an audited statement of expenditure. Unspent funds must be returned to the Central Office within two months of our receipt of the audited statement.

9. For clarity, I would like to remind you that for work on Marion Island, the student will have to be in possession of a passport valid for the entire period. The passport may be obtained on the project running expenses. Likewise, for the relief voyage, the student must be declared medically fit by his/her doctor, and this must be accompanied by a statement indicating the student's blood group. Furthermore, for your, or your designated representative's, travel to Marion Island for the relief, you will require a passport valid for the entire period, and a statement from your doctor indicating that you are fit, as well as indicating your blood group (for emergency medical purposes). The costs for these items may be taken from the project running expenses.

10. All activities at the Prince Edward Islands are regulated by the Prince Edward Management Plan. All personnel involved in your programme must be familiar with

the provisions of the management plan and will be required by the DEA&T to sign a document indicating that this is the case.

11. In response to this offer I require from you a letter of application for this programme providing the following: 1. The student's name and confirmation of registration for B.Sc. (Hons.) at your institution for 2002, as well as a cv for the student or a copy of his/her transcripts for B.Sc.; 2. A letter from the Head of Department confirming that the student will be allowed to travel to Marion Island for the relief from 26th March to 3rd May 2002; 3. A statement indicating whether funds should be transferred to your institution or managed from the University of Stellenbosch; 4. If the former, full banking details of your institution as well as the name, address and fax number of the person that needs to be notified for tracking of the funds once they have been transferred. 5. If the latter, I require full details of the bank account of the student (Bank, Branch, Branch Code, Account type, Account Number, Full Name of Account Holder), which must be verified by the bank in question. I also require these details for the person who will be responsible for purchase of running items and who needs to be refunded. Once I have these details we will transfer the funds and send you an electronic version of the student agreement. You need to sign both copies and return them to us. We will then sign them and return one to you. I have attached a draft version of this agreement for you to examine.

I realize that this list of requirements appears substantial, but I would like to make the conditions of award and our requirements clear from the outset. Furthermore, we have fairly stringent reporting procedures to DEA&T and to USAID and have to keep to these.

As soon as I have received a letter from you I will proceed. If you have any concerns please do not hesitate to contact me at (021) 808-2385, or 082 788-1410. For administrative problems you may also contact the Research Coordinator, Mr. Richard Mercer, at 083 718-9513. I look forward to hearing from you.

Regards

**STEVEN L. CHOWN**
**PROJECT LEADER**
**USAID CLIMATE CHANGE RESEARCH CAPACITY BUILDING PROGRAMME**

## ANNEX F. Advertisement for Hons. Positions

-----Original Message-----
**From:** Chown SL Prof
**Sent:** 25 February 2002 01:56
**To:** 'BETTIE@nrf.ac.za'
**Subject:** Opportunities for Honours students at S.A. Universities

Hi Bettie

Could you please circulate the item below. I would be most grateful.

Thanks

Steven

USAID/DEA&T/University of Stellenbosch Capacity Building Programme in Climate Change Research at the Prince Edward Islands

The University of Stellenbosch in collaboration with DEA&T has been awarded a grant by USAID to support capacity building in climate change-related research at the Prince Edward Islands.

As part of this grant, two bursaries to the value of R 15 000 each are available to B.Sc. (Hons.) students with either Zoology, Entomology, Botany or a closely related field (e.g. Conservation Biology) as majors, registered at any South African University for the 2002 year.

Application Criteria and Requirements
1. Applications must be from students belonging to a historically disadvantaged group.
2. The succesful applicants must must base the research project portion of their B.Sc. (Hons.) on an aspect of terrestrial ecology, or molecular systematics of invertebrates, at Marion Island.
3. The successful applicants must travel to Marion Island from 26 March to 5 May 2002.
4. A letter from the Head of the applicable Department must accompany the application indicating that if the applicant is successful, the Department will allow her/him to travel to Marion Island for the 5 week period as mentioned in Criterion 3, and that this will not disadvantage the student in his/her pursuit of an Hons. degree at the institution.
6. The application package should include the following:
A. A cv of the applicant, including transcripts from the final year of the B.Sc. degree;
B. One A4 page outlining why the applicant thinks he/she should travel to Marion Island and what aspect he/she would like to work on, countersigned by a project supervisor from the institution;
C. A page containing the name, address, fax no. and e-mail address of the supervisor, countersigned by both student and supervisor.
7. All applicants must be physically fit and if successful in their application, will be required to fax through a statement from their doctor/clinic indicating that they are healthy and specifying their blood group (for first aid purposes at Marion Island).

Selection Criteria
A combination of 3rd year scores, excellence on the grounds of the curriculum vitae, and quality of the motivation will be used to select the final candidates.

Additional Benefits and Requirements
1. Supervisors of the successful applicants will be awarded a grant of R 5000 to partly cover the costs of subsistence and travel of the student to Cape Town, from where the research vessel, the S.A. Agulhas, leaves for Marion Island. Although return airfare from a major city to Cape Town will also be provided to the student, there are local accommodation costs and there could be local travel costs to a major city. The remainder of the R 5000 can be used to cover running costs of the supervisor and student, and can be spent on any reasonable running cost items.

2. All subsistence and travel costs to and from Marion Island and at Marion Island will be covered by DEA&T. Protective outer clothing will also be provided as is routinely done for relief personnel, although this clothing must be returned to DEA&T at the end of the relief voyage.

3. At Marion Island, supervision of the students will be provided by the research group led by Steven Chown. A dedicated staff member will be responsible for the day to day guidance of the students at Marion Island.

4. The facilities at Marion Island are excellent, including state-of-the-art laboratories, electronic communication with South Africa, and comfortable acommodation. The field opportunities are unbelievable for any biologist interested in terrestrial and pelagic ecoystems and their interaction.

5. Successful applicants, their supervisors, and an appropriate administrative authority (Head of Research) at the Institution will be required to sign an agreement with the University of Stellenbosch indicating that the funds will be spent as set out above, and that the conditions of award will be adhered to. This agreement will indicate that if the students do not obtain an Hons degree at the end of 2002 (or by latest February 2003), the funds will have to be returned to the University of Stellenbosch.

Further Information
Further information on the kinds of small projects that potentially could be done at Marion Island can be obtained from Prof. Steven Chown at (021) 808-2385, or e-mail: slchown@sun.ac.za.

Applications and closing dates
All applications should be submitted by fax to S.L. Chown at the address indicated below.

Owing to the late finalization of the USAID/DEA&T/US programme the closing date for applications is, unfortunately, 5th March 2002. However, these awards will also be available in 2003, and a request for applications will go out later in 2002 for the 2003 field season.

Steven L. Chown
Department of Zoology
University of Stellenbosch
Private Bag X1
Matieland 7602
South Africa

Tel: +2721 808-2385
Fax: +2721 808-2405
E-mail: slchown@sun.ac.za
http://www.sun.ac.za/zoology

**ANNEX G. Conditions of Award of M.Sc. and Ph.D. Bursaries**

Spatial, Physiological and
Conservation Ecology Group
Direct Tel: +2721 808 2385
E-mail: slchown@sun.ac.za

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March 2002

Dear X

**USAID/DEA&T/U. STELLENBOSCH CLIMATE CHANGE CAPACITY BUILDING PROGRAMME**

*Apropos* our recent conversations regarding the possibility of your participation in this project I would like to provide you with additional information regarding the Programme requirements and what we can offer.

1. The programme is a collaborative programme between the University of Stellenbosch and the South African Department of Environmental Affairs & Tourism, funded by the United States Agency for International Development. I am responsible for overall project management and will be assisted by Mr. Richard Mercer who will run the Central Office at the University of Stellenbosch. As part of this programme we are at liberty to engage expertise from elsewhere to assist with this work. Hence this letter.

2. We can provide you with two bursaries to the value of R 35 000 per year for a Masters level student, available for a maximum of two years, and R 45 000 per year for three years for a Ph.D. level student. The running costs accompanying these bursaries amount to R 15000 per student per year. These amounts will be transferred to yourself and you will be responsible for submitting an audited statement of expenditure to us. Running expenses cover any legitimate expense. Student travel within South Africa to team training, and to and from Cape Town (once) will be covered independently by the Central Office, as will your travel to at least one workshop hosted by this Programme. There are also funds available for your participation in the Marion Island Relief Voyages during the time your students are involved. Unfortunately, running expenses cannot be used for other domestic or international airline travel. If you do not require internal travel to Cape Town, these funds may be re-assigned for other purposes on request to the Central Office.

3. The South African National Antarctic Programme will cover all costs of travel to and from the Prince Edward Islands, subsistence on Marion Island, and protective clothing at the island, subject to their usual terms and conditions (including

participation of the students in team training in Pretoria, one month prior to departure for Marion Island).

4. The student's projects must concern variation in life history characteristics (including population density) of invertebrates across the altitudinal and habitat gradient on Marion Island in the context of local environmental change. The students must spend at least one full year each on Marion Island.

5. The students should preferably be from previously disadvantaged population groups (black, coloured, Asian), and must be South African citizens. If you can show that country-wide advertising through the usual distribution lists and academic channels (direct contact with University Departments, NRF and ZSSA lists etc.), and consultation with ourselves at the Central Programme Office, has failed to secure students from such groups, then other South African students can be approached. This requirement is not applicable to the Ph.D. student.

6. Both yourself and the students will be required to sign an agreement with the University of Stellenbosch, countersigned by your Institution's administration, indicating that if the student leaves the project within three months of its inception, the full bursary amount and the remaining running expenses will be returned to the University of Stellenbosch; that if this occurs after one year, 50% of the bursary and all remaining running costs must be returned; and after two years, or failure to complete the degree, 30% of the bursary and all remaining running costs must be returned. This agreement will also specify that DEA&T, USAID, and The University of Stellenbosch must be acknowledged for support in all products of the research.

7. The Intellectual Property Rights and data ownership will remain yours, with the understanding that all data must be submitted to the Central Office for archiving within six months of completion of the project, and that these data can be released for public use five years after completion of the project. In this respect, the Central Office will undertake not to release any of your data without your express permission within the first seven years after commencement of your project, and will notify you of requests for your data following that so long as the Central Office remains operational. On closure of the Central Office all data in the archive will revert to the DEA&T. This arrangement is in keeping with the provisions of the Antarctic Treaty, which the DEA&T apply to all of the research they fund in the Southern Ocean and Antarctic regions.

8. You will be required to submit annual progress reports over the duration of the project and a final project report on its completion. These must follow the Antarctic & Islands reporting format, but should be submitted electronically. Both you and your Institution's appropriate authority should sign a covering letter and send this as a hard copy. The covering letter need not be accompanied by the audited statement (of which one must be submitted annually), but this would be preferable.

9. For clarity, I would like to remind you that for work on Marion Island, the students will have to be in possession of a passport valid for the entire period. The passport may be obtained on the project running expenses. Likewise, the student must be declared medically fit, and the DEA&T will arrange for and finance these tests. Please take note that the medicals involve tests for all STDs including HIV/AIDS.

Furthermore, for your, or your designated representative's, travel to Marion Island for the relief, you will require a passport valid for the entire period, and a statement from your doctor indicating that you are fit. The costs for these items may be taken from the project running expenses.

10. All activities at the Prince Edward Islands are regulated by the Prince Edward Management Plan. All personnel involved in your programme must be familiar with the provisions of the management plan and will be required by the DEA&T to sign a document indicating that this is the case.

I realize that this list of requirements appears substantial, but I would like to make the conditions of award and our requirements clear from the outset. Furthermore, we have fairly stringent reporting procedures to DEA&T and to USAID and have to keep to these.

Of course, this letter does not amount to a formal agreement or contract, but simply sets out the conditions of award that would apply if you agreed to work with us. If you see your way through to participating in this Programme, which I very much hope you will, I would appreciate a reply from you as soon as is possible, but preferably before X March 2002. In your letter of reply, I would be grateful if you would indicate your willingness to participate in the USAID Climate Change Capacity Building Programme as a supervisor of two students working on invertebrate ecology under the conditions specified. In turn, your letter will be considered as nothing more than a formal statement of intent. With the transfer of funds to you we will formalize the agreement and negotiate any difficulties.

If you have any concerns please do not hesitate to contact me at (021) 808-2385, or 082 788-1410. Mr Richard Mercer, the Research Coordinator can also be contacted at 083 718-9513.

I look forward to hearing from you.

Regards

**STEVEN L. CHOWN**
**PROJECT LEADER**
**USAID CLIMATE CHANGE CAPACITY BUILDING PROGRAMME**

**ANNEX H. Invitation to Scientific Assessor**

Spatial, Physiological and
Conservation Ecology Group
Direct Tel: +2721 808 2385
E-mail: slchown@sun.ac.za

PROF. K.J. GASTON
BIODIVERSITY & MACROECOLOGY GROUP
DEPARTMENT OF ANIMAL & PLANT SCIENCES
UNIVERSITY OF SHEFFIELD
SHEFIELD S10 2TN
UNITED KINGDOM

X March 2002

Dear Prof. Gaston

**USAID/DEA&T/U. STELLENBOSCH CLIMATE CHANGE CAPACITY BUILDING PROGRAMME**

*Apropos* our recent conversations regarding the possibility of your participation in this project as part of the Programme Steering Committee I would like to provide you with additional information regarding the Programme, and what would be required.

1. The programme is a collaborative programme between the University of Stellenbosch and the South African Department of Environmental Affairs & Tourism, funded by the United States Agency for International Development. I am responsible for overall project management and will be assisted by Mr. Richard Mercer who will run the Central Office at the University of Stellenbosch. As part of this programme we are at liberty to engage expertise from elsewhere to assist with this work. Hence, we will collaborate with researchers at the Universities of Cape Town and Durban-Westville.

2. Essentially this Programme has as its major goals the development of capacity, especially among previously disadvantaged groups, to undertake ecological and other research concerned with the likely effects of climate change on the fauna and flora of Marion Island, but with the view that expertise in this field would be broadened to the benefit of South African scientific capacity.

3. The Executive Summary of the Proposal Document on which USAID based the funding reads as follows:

Global climate change is a serious, complex threat facing both human and other life. As a consequence of its interaction with habitat destruction and the worldwide human distribution of invasive species, global climate change is posing a significant threat to the biodiversity estate that humans are totally dependent on for their welfare. In consequence, the Framework Convention on Climate Change has urged nations to develop an understanding of the impact of climate change on their biodiversity estate, as well as plans for mitigation of its effects. As is the case in many other countries, the South African science community faces a lack of appropriate information and skilled human resources to deal effectively with these requirements, both with regard to its continental biodiversity estate, and the southern ocean, which forms one of its most significant resource bases. In order to develop a more comprehensive understanding of marine and terrestrial systems so as to better predict the likely impacts of climate change, there have been several calls, most significantly in the context of an International Long Term Ecological Research Programme, for the establishment of a programme of climate change research and science capacity development. It has been suggested repeatedly that the sub-Antarctic Prince Edward Islands (and especially the larger, Marion Island) should form a key component of such a program. There are several reasons for this. First, because of its generally low number of species, well documented cases of invasion by aliens, and considerable altitudinal gradient in diversity, Marion Island is at once more straightforward to investigate than biodiverse continental systems, yet it is also wholly comparable to such systems. Second, the terrestrial and marine systems of the islands are closely linked in a feedback loop that is now beginning to be understood. Third, Marion Island has shown significant climate change both in the geological past, and over the last 50 years, and this change is having effects, on both the terrestrial and marine systems, that have been documented in preliminary investigations. Finally, the islands have been subjected to only minimal human disturbance, most of which has been well documented, thus allowing investigations of biocomplexity that are not confounded by continual human interference.

Here, an integrated research programme investigating the ways in which climate change is likely to affect biocomplexity at several hierarchical levels in terrestrial systems is set out. The major aims of this programme are: 1. to develop a deeper understanding of the likely impacts of climate change on these levels, and their interactions, so as to be better able to predict the likely future course of climate change events both in the southern ocean and elsewhere; 2. to contribute to the development of the necessary human resource capacity that will allow South Africa to enhance its ability both to predict the impacts of climate change on its biodiversity estate, and to mitigate the effects of this change.

This will be done by means of a capacity building research programme that will address the following research objectives

- Determine the change in relationships between species richness and functional group diversity across the elevational gradient, a useful surrogate estimate of climate change, at Marion Island,

- Investigate the limits to growth and activity of species and the ways in which these limits govern species performance,

- Determine the extent of phenotypic plasticity and genetic variation in key indigenous and introduced species and the extent to which this might allow differential success under climate change scenarios,

4. What we would require of you is to assist with steering this Programme by providing advice on the work and critical comment on its progress. This would involve assessment of the annual progress as set out in our draft progress report (which will be finalized after your comments), discussion with the Project Leader (myself) and the project researchers (these vary from year to year) regarding problems with the work or missed research opportunities, and participation in at least one workshop assessing the scientific productivity and direction of the programme (to be held midway through the research). In short, we would like you to act as a referee, pointing out where things could be improved and where we may make better use of opportunities. Of course, if synergistic research opportunities seem evident to you, we would also appreciate hearing about these, and would welcome your participation in such work.

5. At most your contribution would amount to a total of no more than 12 days over the duration of the Programme. We would cover the costs of your travel and subsistence whenever meetings in Stellenbosch would be required (a maximum of once annually). Unfortunately, however, we would not be able to cover your salary for this period or provide you with an honorarium.

6. Should you agree to serve as a member of the Steering Committee, I would be grateful to hear from you at your earliest convenience, but by no later than X March 2002.

I look forward to hearing from you.

With thanks in advance.

Regards

**STEVEN L. CHOWN**
**PROJECT LEADER**
**USAID CLIMATE CHANGE CAPACITY BUILDING PROGRAMME**