DST-NRF Centre of Excellence for Invasion Biology

ANNUAL PROGRESS REPORT 2010

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March 2011

C·I·B Honours student Fani Given Nyembezi collects data on the impacts of Lantana camara *on rural livelihoods along the Mthatha River, Eastern Cape Province.*

CONTENTS

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Reporting period from 1 January 2010 to 31 December 2010

IDENTIFICATION

Name of Director	:	Professor Steven L. Chown
Name of CoE	:	DST-NRF Centre of Excellence for Invasion Biology
Abbreviated CoE Name	:	Centre for Invasion Biology
Host institution	:	Stellenbosch University
Date completed	:	Report: 23 February 2011
	:	Financials: 16 March 2011

Summary of progress against 5 KPAs

(i) Research

The C·I·B continues to perform at a high level in terms of research output. From a 'numbers' perspective, research output has remained at over 90 peer-reviewed papers per year. Moreover, a growing number of these papers is in journals with an impact factor of above 3.5, and two contributions appeared in journals with imact factors greater than 15. The paper in *Science* is proving to be an exceptionally influential one. As demonstrated in this report, the research outputs are now well-aligned with the Strategic Plan of the Centre and the match between the strategy, spending and output is now more seamless than it has been in the past. Ongoing comments from peers indicate that the Centre has further grown its global reputation as a research leader in the field of biodiversity and the impacts of biological invasions thereon.

(ii) Education and Training

Student training remains a key means to achieving the research ends of the Centre. Seventy-five students were supported in 2010, more than half of them women, and *c*. 43% from the designated groups. Sixteen students graduated, representing six Honours, seven Masters, and three Ph.D.s. The Biodiversity Conservation Academy attracted students from across the country. Ten students and four interns from the South African National Biodiversity Institute participated in the Academy, which included lectures and field work led by two Centre of Excellence Directors.

(iii) Information Brokerage
The Iimbovane Outreach Project's expansion has been a tremendous success, with all schools indicating the beneficial contributions of the project. In 2010, 28 schools, 31 educators and 1850 learners participated in the project. Direct participation was supplemented by value addition to the activties of schools and learners through the use of Iimbovane material for other projects. Much interest has also been expressed in the project by an undergraduate student at the University of Venda who has started implementing a similar system there, though at a reduced level. Educators across the country have been inspired by the successes of the project as indicated by their response to Ms. Keafon Jumbam's presentation to the 2nd Annual Working for Water National Teachers Conference in Polokwane. Ongoing support by the Rand Merchant Bank Fund, AfriSam and the Anglo American Chairman's fund, as well as the Western Cape Education Department, continue to enable the project to interact successfully with its partners. In 2010, the C·I·B featured in an exceptionally wide range of print and other media across the globe. The Information Retrieval and Submission System used by the C·I·B continues to function effectively. It now contains 512 publications, and over two hundred datasets and theses. A further highlight for 2010 was the five-day course on *Biological invasions: recent advances and traditional tools* held during October 2010 at Howick in KwaZulu-Natal. The course was a joint venture between the C·I·B, as part of its collaborative research project with Working for Water (WfW), and the Early Detection and Rapid Response (EDRR) Programme of SANBI. Finally the C·I·B celebrated the 2010 International Year of Biodiversity by hosting, in collaboration with Stellenbosch University's Department of Botany and Zoology, a series of four public lectures on the topic on behalf of Stellenbosch University.

(iv) Networking
Current formal agreements with the C·I·B's partners were maintained, whilst informal networking activities through joint projects continued to grow in number and diversity. Two new core team members were appointed by the C·I·B Board in 2010. Dr. Llewellyn Foxcroft (Scientist: Invasion Ecology, Savanna Ecology Research Unit, SANParks) and Dr. Olaf Weyl, Senior Aquatic Biologist at the South African Institute for Aquatic Biodiversity (SAIAB). A Research Associate agreement was concluded with Prof. Armanda Bastos, Department of Zoology and Entomology, University of Pretoria.

(v) Service rendering
The C·I·B continues to deliver services to a wide range of partners and clients. The year 2010 saw the delivery of a range of reviewing and editorial services, including draft working papers on behalf of the Scientific Committee on Antarctic Research. A major contribution on climate change and biological invasions to South Africa's Second Report to the United Nation's Framework Convention on Climate Change was also completed.

What was the gender impact of your work?

Gender equity continues to form a major theme underlying the C·I·B's activities. Leadership in the C·I·B's outreach work, long-term projects, and social science projects is provided by women, who are entirely responsible for the planning and implementation of these projects. Women constitute close to 60% of the personnel/students associated with the centre and 77% of the Stellenbosch hub staff. Several projects are now explicitly investigating either the role of women in science or the impacts of control interventions (such as the programmes run by Working for Water) on women.

Red Flags. Please indicate any major concerns you have for the future of your CoE

The C·I·B has continued to grow the quality of its performance, but three areas remain concerning. First, the seeming lack of appreciation in certain key government areas for impacts of invasions on livelihoods and the economy, despite intensive activity of the C·I·B and others in the sector to highlight these matters. In a country that seeks to improve urban and rural livelihoods and to grow its economy sustainably, these are worrying signs indeed. Second, black student participation has declined slightly within the C·I·B. Steps to manage the matter have been taken and participation should improve. However, these may have to become more drastic in the future if the participation rate does not show an increase to exceed the SLA targets. Finally, a steep rise in the mean time to complete a Ph.D. has taken place. Good reason exists for this (an outlier essentially) and the value is expected to decline to within the target range.

General Comments

The C·I·B continues to be widely recognized internationally as one of the key research entities in the field. Thanks are due to the Department of Science and Technology, the National Research Foundation, Working for Water, Stellenbosch University, the South African National Biodiversity Institute, the Rand Merchant Bank Fund, AfriSam, the University of Pretoria, the Anglo American Chairman's Fund, C.A.P.E., South African National Parks, CapeNature and all of our partners and collaborators for support over the past year.

1 Scientific research

The C·I·B's research remains concerned primarily with the rates and biodiversity impacts of biological invasions, how these might be reduced and remediated through appropriate policy interventions, and how interactions among global change drivers might further influence the impacts of biological invasions and alter policy decisions.

The approaches adopted to address these goals are wide ranging and often inter-disciplinary. They encompass top-down, themed research, investigator-driven work, empirical and theoretical studies and work that spans the full spectrum of knowledge, from the non-instrumental to the instrumental. The overarching objectives are to undertake innovative, leading research in biology, and to develop the policy implications and social dimensions of this work, with biological invasions forming the core around which the research revolves.

Several themes characterise the core of the Centre's work. These themes have their origins in the work originally proposed in the C·I·B's application to the CoE programme, but have been further streamlined through the strategic planning process, and have developed in concert with the field as a whole and the strengths of the C·I·B membership. Particularly significant additions to the work originally proposed are:

- *Research for the Integrated Management of Invasive Alien Species* in collaboration with the Working for Water Programme, and
- *Invasion Biology in Support of Environmental Sustainability During Times of Change* within Stellenbosch University's HOPE project (http://thehopeproject.co.za/hope/Pages/default.aspx)

Much of the work undertaken over the past year is still in progress, and in keeping with our reporting policy, will be reported once published. This report therefore largely concerns published work, except for progress reports on the long-term work.

1.1 Progress

The C·I·B had another excellent year in terms of the research undertaken across the Core Team and among our partners. Research output in the primary literature amounted to 93 peer-reviewed publications, with significant contributions such as to the journals *Science*, *Nature*, *Annual Review of Environment and Resources*, *Biological Reviews* and *Philosophical Transactions of the Royal Society B*. Contributions to books were likewise well represented, with 11 chapters on topics ranging from macrophysiology of cold-hardiness in insects (Chown and Sinclair 2010) to an evaluation of soil degradation state along fence lines (Haarmeyer *et al.* 2010). The overview below, following the research themes identified in our Strategic Plan, provides highlights of the C·I·B's work over the past year. A full list of published work can be found in Section 8, and the C·I·B home page has an excellent series of overviews of noteworthy and newsworthy research publications (see www.sun.ac.za/cib and follow the links).

1.2 Long-term Research

1.2.1 Long term change in insect assemblages

One of the primary long-term projects is the investigation of variation in ant assemblages through space and time across four large-scale gradients. The first three projects encompass repeated, bi-annual sampling across altitudinal gradients in the Cederberg (8 years), Drakensberg (4 years) and Soutpansberg (2 years), while the fourth draws on data collected by the Iimbovane Outreach Project across the Western Cape. All of these projects involve either or both learner and student contributions to data collection, and the data are archived in the Information Retrieval and Submission System of the C·I·B (see Section 3.2.5). The projects are supported by C·I·B central funds, by each of the primary institutions involved (Stellenbosch, Pretoria and Venda Universities) and, in the case of the Iimbovane project, by corporate social investment (currently Rand Merchant Bank, AfriSam, Anglo American).

These projects are all largely on track, with identifications being up to date for all of them except for the Cederberg, where ant identifications are current up to and including 2008, with the 2009 and 2010 data being scheduled for identification for this year, and the 2011 data then being identified in 2012 and so on. Two large, additional projects have been started to add value especially to the Cederberg and Iimbovane work, but also in the case of the second project to the other transects. In the first case, body mass data for more than 4 000 individual ants are now available and the critical thermal limits have been assessed for more than 73 species. Together with annually collected data on vegetation height, cover, litter abundance, and time since last fire, the information is starting to enable us to distinguish short-term from long-term influences on the ant assemblages. This is especially crucial for the Cederberg transect where we see step changes in diversity (richness, abundance and average size) at certain elevations. Our preliminary analyses indicate that these step changes are not a consequence of fire return interval or of vegetation change, but are probably a consequence of changes in ambient environmental conditions.

That average environmental conditions should influence ant diversity is not unexpected, and the data from across the Western Cape transects are showing this clearly. However, what they are also demonstrating is that both biome identity and disturbance have clear impacts on ant assemblages. Transformation is particularly noticeable in Fynbos and Succulent Karoo, which in turn have very different ant assemblages (Figure 1) (Braschler *et al.* 2010 – see the outputs list at Section 8.3 of this report for this and other citations). Not only are richness and abundance affected, but initial data suggest that body size, which is closely linked to many functional traits, is also markedly influenced by changing environmental disturbance regimes.

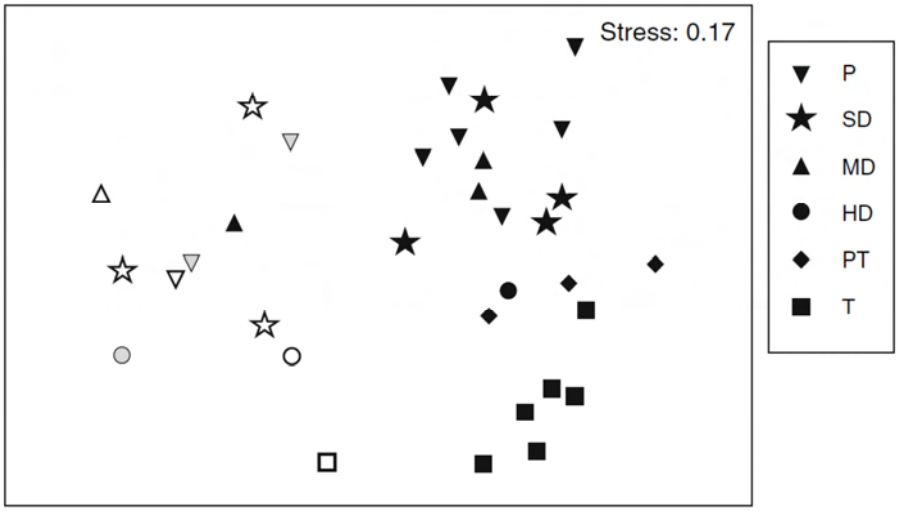


Figure 1. Outcome of a non-metric multidimensional scaling analysis of all sites investigated in the Iimbovane project. Black symbols are for Fynbos, open symbols Succulent Karoo, and grey symbols Nama Karoo. P = pristine site, D = disturbed (prefixes S= slightly, M= moderately, H = highly), T = transformed (prefixes P = partially, no prefix means completely transformed).

The second development with our long-term work is the funding by the IDRC of a project to increase South Africa's contributions to the Barcoding of Life Database. The project is coordinated by Prof. Paul Skelton of SAIAB, and the C·I·B is a partner contributing ants from all of our projects to the initiative. The sequencing of the mitochondrial cytochrome oxidase I gene is being done at the BOLD facility in Guelph Canada, and ants from all of our projects are being sent there for barcoding. The data are contributed to the BOLD system, but remain ours for exclusive use until the outcomes of the project are published – they then go public. The C·I·B is also contributing to BOLD via a global Collembola project that was funded partly through an SA-France bilateral grant, but that we are continuing within the current barcoding agreement.

1.2.2 Long term changes to the Prince Edward Island ecosystem

Two notable sets of work have emerged in 2010 from this area of interest. In the first, we show how across the Southern Ocean islands, the introduction of alien species has changed plant and insect assemblages (Shaw *et al.* 2010). In particular, the aim of the work was to investigate taxonomic homogenization and/or differentiation of insect and vascular plant assemblages across the Southern Ocean Islands (SOI), and how they differ with changing spatial extent and taxonomic resolution. Such an approach has not been attempted for insects in any system, mostly because of the inadequacy of the available information. Our databases enable us to do so. Thus, we used data from twenty-two islands located across the Southern Ocean, further subdivided into five island biogeographical provinces. These islands were used because comprehensive data on both indigenous and non-indigenous insect and plant species are available. An existing database was updated, using newly published species records, identifying the indigenous and non-indigenous insect and vascular plant species recorded for each island. Homogenization and differentiation were measured using Jaccard's index (JI) of

similarity for assemblages across all islands on a pairwise basis, and for island pairs within each of the biogeographical provinces. The effects of taxonomic resolution (species, genus, family) and distance on levels of homogenization or differentiation were examined. To explore further the patterns of similarity among islands for each of the taxa and groupings (indigenous and non-indigenous), islands were clustered based on JI similarity matrices and using group averaging.

Across the SOI, insect assemblages have become homogenized (0.7% increase in similarity at species level) while plant assemblages have become differentiated at genus and species levels. Homogenization was recorded only when pairwise distances among islands exceeded 3000 km for insect assemblages, but distances had to exceed 10 000 km for plant assemblages. Widely distributed non-indigenous plant species tend to have wider distributions across the SOI than do their insect counterparts, and this is also true of the indigenous species. Insect assemblages across the SOI have become homogenized as a consequence of the establishment of non-indigenous species, while plant assemblages have become more differentiated. The likely reason is that indigenous plant assemblages are more similar across the SOI than are insect assemblages, which show greater regionalization. Thus, although a suite of widespread, typically European, weedy, non-indigenous plant species has established on many islands, the outcome has largely been differentiation. Because further introductions of insects and vascular plants are probable as climates warm across the region, the patterns documented here are likely to change through time.

In the second set of work we have demonstrated how landscapes at the islands have changed dramatically with warming of the climate. The comprehensive analyses of the information obtained from transect-related work is still underway. However, by means of the work funded under the SANAP Antarctic Legacy Project, coordinated by the C·I·B, we have been gathering historical images of the people, infrastructure and environments at the islands. These images have illustrated both social and environmental changes at the islands (Figs. 2, 3), and the latter are especially noteworthy from a global change and invasions perspective. To date they have been published in a popular book about the islands (Terauds *et al.* 2010) and a chapter for the South African Environmental Observatory Network book that will appear in 2011. The formal analyses are not only of the transect-related data collected by our projects and by Prof. Brian Huntley for his M.Sc. thesis in the 1960s, but also of the image material and a comprehensive set of atmospheric corrected satellite images of the islands. The images, a fine-scale digital elevation model of both islands, and analysis thereof will all become available within the next year (within the restrictions set by data providers).

Figure 2. Hendrik Fister Kop (c. 400 m elevation on Marion Island) in 1966 (top) and in 2009 (bottom). Note the increase in cover of the indigenous grass, *Agrostis magellanica*. Images by Brian Huntley and Aleks Terauds.

Figure 3. The only known photograph of the fire that destroyed much of the scientific station on Marion Island on 26th June 1966. The SANAP Antarctic Legacy Project is unearthing and archiving material such as this (photo reproduced from the collection of Bert Quinn).

1.3 Short-term Research

1.3.1 Biodiversity foundations

Determining the impacts of environmental change, including invasions, requires that patterns in and the processes underlying diversity be understood. Such basic understanding can also lead to the redevelopment of whole fields of enquiry leading to better comprehension of impacts and in consequence, better methods for adapting to or mitigating change. These points are well illustrated in two recent reviews led by C·I·B members. In the first (Chown *et al.* 2010 *Climate Research*) we acknowledge that much attention has been given to forecasting the likely effects of ongoing climate change on biodiversity, and that a substantial and often contentious literature has developed about how changes in species' ranges should be modelled and how additional biological mechanisms might be incorporated to improve their utility. Nonetheless, two areas stand out as relatively under-appreciated: the importance of understanding a species' physiological capacities when forecasting its response to climate change, and the likely influence that capacities for genetic change across generations and changes in plastic responses, or the lack thereof, will have on a species' response. Although perhaps not as well developed as correlative approaches to understanding species responses to change, mechanistic approaches are advancing rapidly. Thus, the review explores several of the key messages emerging from the mechanistic approach, embodied in evolutionary physiology, to understanding and forecasting species responses to climate change.

In the second review (Chown *et al*. 2010, *Evol. Ecol.*), this theme of global environmental change (GEC) is continued, but now dealing with the fact that predicting specific changes in systems where initial conditions, instabilities, and model errors have large impacts on the outcome is problematic, and noting that predictive community ecology has been deemed unworthy of pursuit or an unreachable goal. The review illustrates how new developments in large-scale biology provide ways of thinking that might substantially improve forecasts of local and regional impacts of climate change. Most notably, these are the explicit recognition of the regional and landscape contexts within which populations reside, the matrix approach (Figure 4) that can be used to investigate the consequences of population variation across space and within assemblages, and the development of macrophysiology, which explicitly seeks to understand the ecological implications of physiological variation across large spatial and temporal scales. The review further explores how a combination of these approaches might promote understanding and forecasting of the effects of global climate change and perhaps other GEC drivers on biodiversity. Throughout the focus is on the population level, examining the ways in which environmental variation might be translated through performance and its plasticity to variation in demography.

The explicit focus on physiological traits is important because of the role they play in mediating environmental change, as has been demonstrated recently in several prominent works. Perhaps a significant weakness of some of these studies is their failure to take into account the nature and form of both adaptive and plastic responses to environmental change. Exploring these responses also forms a major component of the work on biodiversity foundations undertaken by the C·I·B.

i Species / *j* Sites	Site A (40°S)	Site B (38°S)	Site C (35°S)	Site D (30°S)	Mean CTmin (°C)	Mean latitude (°S)
Sp. 1	4.0	5.0	6.0	8.0	5.8	35.8
Sp. 2	3.0	4.0	7.0		4.7	37.7
Sp. 3	3.0	4.0			3.5	39.0
Sp. 4	2.0				2.0	40.0
Mean CTmin (°C)	3.0	4.3	6.5	8.0		
Variance	0.7	0.3				

Figure 4. A matrix of species (i) by sites (j) indicating how physiological variables may be included in such a matrix and can provide insight into intraspecific, interspecific and assemblage-level variation. The variable is critical thermal minimum (CTmin). The red rectangle indicates intraspecific variation across space. Interspecific variation (green rectangle) is calculated as a mean value for the species at the centre of their latitudinal range, whilst assemblage characteristics are the mean and variance a trait across all species at a given site (blue rectangle).

For example, understanding the responses of metabolic rate to temperature change is important because metabolic rate is a measure of the costs of living. One study undertaken with partners to investigate such variation was of the reasons for acclimation-related metabolic rate variation in a dung beetle species (Terblanche *et al.* 2010). Variation in metabolic rate in response to environmental conditions has been explained largely in the context of two contrasting hypotheses, namely metabolic depression in response to stressful or resource (e.g. water) limited conditions, or elevation of metabolism at low temperatures to sustain life in extreme conditions. To deconstruct the basis for metabolic rate changes in response to temperature variation, here we undertake a full factorial study investigating the longer- and short-term effects of temperature exposure on gas exchange patterns. We examined responses of traits of gas exchange [standard metabolic rate (SMR); discontinuous gas exchange (DGE) cycle frequency; cuticular, respiratory and total water loss rate (WLR)] to elucidate the magnitude and form of plastic responses in the dung beetle, *Scarabaeus spretus*. Results showed that short- and longer-term temperature variation generally have significant effects on SMR and WLR. Overall, acclimation to increased temperature led to a decline in SMR modulated by reduced gas exchange frequency, reduced cuticular WLRs and reduced total WLR. Respiratory WLR was reduced in 15°C-acclimated beetles compared with 25°C-acclimated beetles measured at 25°C, suggesting conservation of water during gas exchange bursts (Figure 5). Overall, this suggests water conservation is a priority for *S. spretus* exposed to longer-term temperature variation, rather than elevation of SMR in response to low temperature acclimation, as might be expected from a beetle living in a relatively warm, low rainfall summer region. These results suggest that the influence of increasing temperatures, and associated water loss, can be mitigated effectively over the short term by phenotypic plasticity.

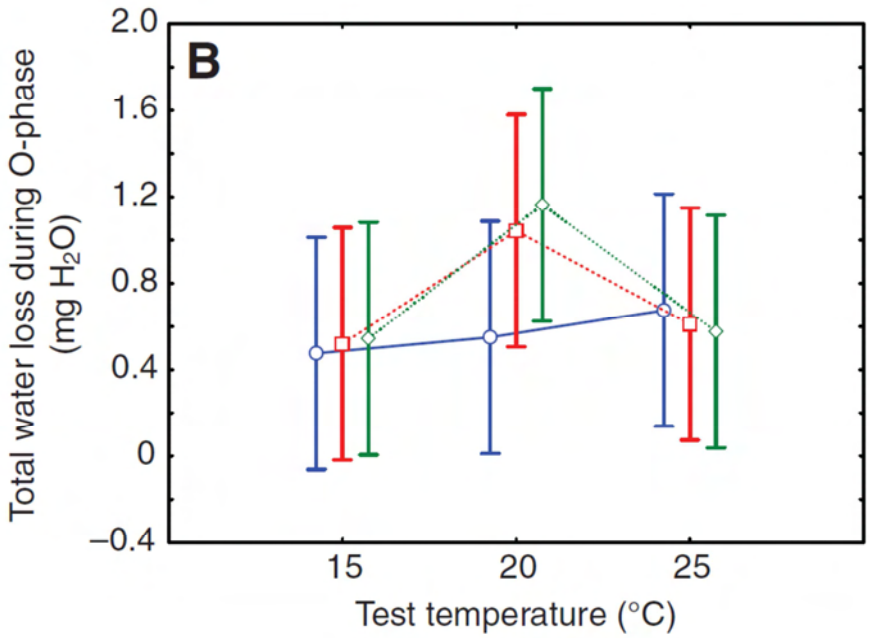


Figure 5. Total water loss (and 95% CIs) during spiracle opening in the dung beetle *Scarabaeus spretus*. Notice how, despite increasing test and acclimation temperatures, individuals regulate gas exchange such that water loss is kept constant. Higher temperatures should lead to higher metabolic rates and greater water loss, but this does not happen. This outcome has important implications for forecasting responses to globally rising temperatures.

A second, related study (Clusella-Trullas *et al*. 2010 *Physiol. Biochem. Zool*.), reports the results of a full-factorial study investigating the responses of active metabolic rate (AMR), voluntary locomotion speed, and cost of transport (COT) to three temperature acclimations (7–10 d; 20°C, 25°C, and 30°C) and three test temperature treatments (2 h; 20°C, 25°C , and 30°C) in a seed harvester ant, *Messor capensis*. Using a strong-inference approach, the study assessed these trait responses in the context of the beneficial acclimation hypothesis and its alternatives. Results showed that AMR was not affected by acclimation temperature, indicating limited phenotypic plasticity for this trait. By contrast, voluntary running speed was consistently higher when ants were acclimated at 25°C, providing support for the optimal acclimation hypothesis. COT was not affected by acclimation or treatment temperature. In addition, while AMR was repeatable and similar across temperatures (r = 0.371–0.683), the repeatabilities of running speed (r = 0.191–0.826) and COT (r = 0.166–0.903) were highly variable, suggesting constraints on ant locomotion under certain thermal conditions. Minimum COT (298 J kg^{-1} m^{-1}) in *M. capensis* was well within the range of values for other terrestrial arthropods of a similar body size. This study emphasizes the need to investigate a variety of performance traits rather than a single one and to expand the limited body of work on plasticity of insect locomotion.

Additional work in the biodiversity foundations field has concerned the evolution and diversity of major taxa in South Africa. Two examples illustrate the variety that constitutes

the biodiversity (in the true sense of the word) of the region. The first provides additional evidence for the significance of Robertsonian translocations and fusions/fissions in chromosomal evolution within Chiroptera (Richards *et al.* 2010). Karyotypic relationships were investigated among four species, representing four families of Chiroptera endemic to the Malagasy region using cross-species chromosome painting with painting probes of *Myotis myotis*: Myzopodidae (*Myzopoda aurita*, 2n=26), Molossidae (*Mormopterus jugularis*, 2n=48), Miniopteridae (*Miniopterus griveaudi*, 2n=46), and Vespertilionidae (*Myotis goudoti*, 2n=44). This study represents the first time a member of the family Myzopodidae has been investigated using chromosome painting. Painting probes of *Myotis myotis* were used to delimit 30, 24, 23, and 22 homologous chromosomal segments in the genomes of *Myzopoda aurita*, *Mormopterus jugularis*, *Miniopterus griveaudi* and *Myotis goudoti*, respectively. Comparison of GTG-banded homologous chromosomes/chromosomal segments among the four species revealed the genome of *M. aurita* has been structured through 15 fusions of chromosomes and chromosomal segments of *Myotis myotis* chromosomes leading to a karyotype consisting solely of bi-armed chromosomes. In addition, chromosome painting revealed a novel X-autosome translocation in *Myzopoda aurita*. Comparison of these results with published chromosome maps provided further evidence for karyotypic conservatism within the genera *Mormopterus*, *Miniopterus* and *Myotis*. Mapping of chromosomal rearrangements onto a molecular consensus phylogeny revealed ancestral syntenies shared between *Myzopoda* and other bat species of the infraorders Pteropodiformes and Vespertilioniformes.

The second example concerns the marine biodiversity of South Africa. A recent review led by a C·I·B member (Griffiths *et al.* 2010) revealed that despite its status as a developing nation, South Africa has a relatively strong history of marine taxonomic research and maintains comprehensive and well-curated museum collections totalling over 291 000 records. Over 3 million locality records from more than 23 000 species have been lodged in the regional AfrOBIS (African Ocean Biogeographic Information System) data centre (which stores data from a wider African region). The currently recorded marine biota of South Africa numbers at least 12 914 species, although many taxa, particularly those of small body size, remain poorly documented. The coastal zone is relatively well sampled with some 2 500 samples of benthic invertebrate communities have been taken by grab, dredge, or trawl (Figure 6). Almost none of these samples, however, were collected after 1980, and over 99% of existing samples are from depths shallower than 1 000 m—indeed 83% are from less than 100 m. The abyssal zone thus remains almost completely unexplored.

South Africa has a fairly large industrial fishing sector, of which the largest fisheries are pelagic (pilchard and anchovy) and demersal (hake), both focused on the west and south coasts. The east coast has fewer, smaller commercial fisheries, but a high coastal population density, with intense exploitation of inshore resources by recreational and subsistence fishers, and this has resulted in the overexploitation of many coastal fish and invertebrate stocks. South Africa has a small aquaculture industry rearing mussels, oysters, prawns, and abalone—the latter two in land-based facilities. Compared with many other developing countries, South Africa has a well-conserved coastline, 23% of which is under formal

protection. However deeper waters are almost entirely excluded from conservation areas. Marine pollution is confined mainly to the densely populated KwaZulu-Natal coast and the urban centres of Cape Town and Port Elizabeth. Over 120 introduced or cryptogenic marine species have been recorded, but most of these are confined to the few harbours and sheltered sites along the coast.

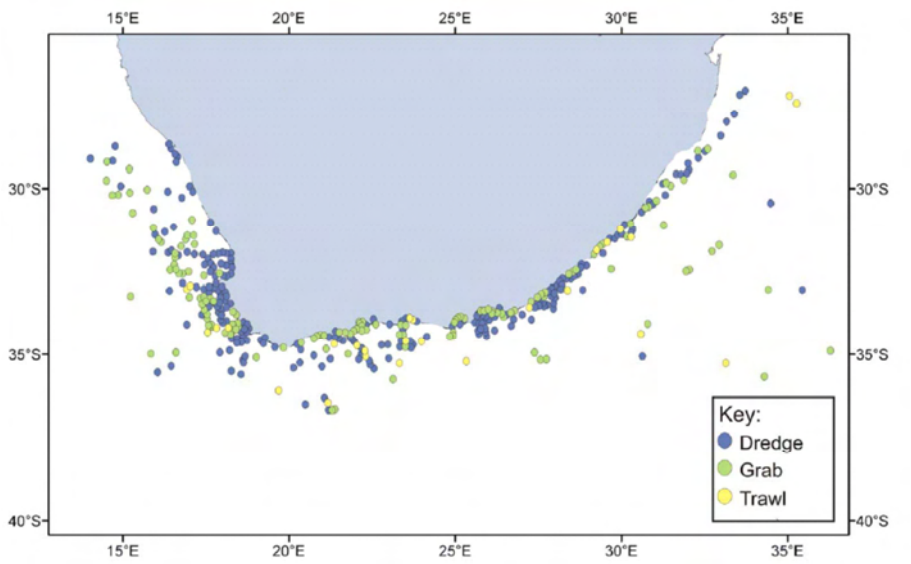


Figure 6. Locations of benthic invertebrate samples around the coast of South Africa.

1.3.2 Biodiversity dynamics through space and time

Much theoretical and empirical work was completed in this area of interest over the past year. Perhaps one of the most significant contributions an exploration of the concept of aggregation, as well as its measurement, because both are pivotal to understanding of species distributions and macroecological patterns (Hui *et al.* 2010 *Ecography*). Using an individual-based model, opinions on the concept of aggregation from the public and experts (trained ecologists) were analyzed in addition to those calculated from a variety of aggregation indices. Three forms of scaling patterns (logarithmic, power-law and lognormal) and four groups of scaling trajectories emerged. The experts showed no significant difference from the public, although with a much lower deviation (Figure 7). The public opinion was partially influenced by the abundance of individuals in the spatial map, which was not found in the experts. With the increase of resolution (decrease of grain), aggregation indices showed a general trend from significantly different to significantly similar to the expert opinion. The over-dispersion index (i.e. the clumping parameter k in the negative binomial distribution) performed, at certain scales, as the closest index to the expert opinion. Examining performance of aggregation measures from different groups of scaling patterns was proposed as a practical way of analyzing spatial structures. The categorization of the scaling patterns of aggregation measures, as well as their over- and in-sensitivity towards spatial structures, thus not only provide a potential solution to the modifiable areal unit problem, but also unveil the

interrelationship among the concept, measures and perceptions of aggregated species distributions.

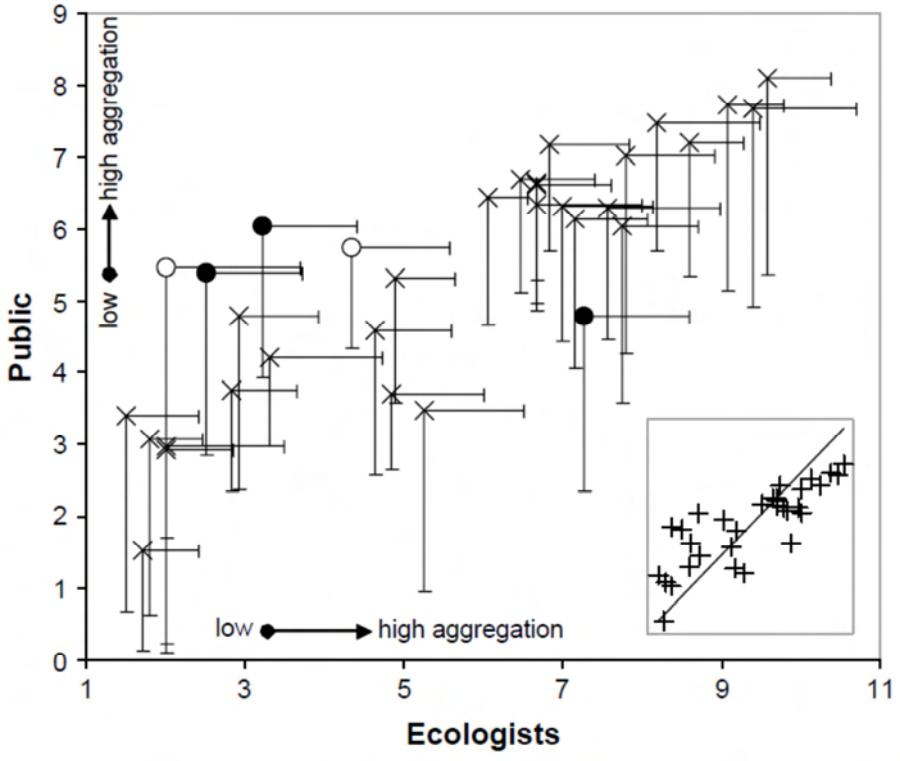


Figure 7. The relationship between the mean assessments of aggregation by ten ecologists and ten members of the public. The error bars in each case are shown and the dots illustrate significant differences while the crosses indicate no difference. The inset shows the plot relative to the y=x line.

Theoretical work also explored the criteria for choosing the appropriate line-fitting method (LFM) and correction estimator for determining the functional allometric relationship, and for predicting the Y-variable accurately (Hui *et al.* 2010 *MEE*). A widely accepted criterion for reducing bias in allometric prediction is to minimize the mean squared residual (MSR) on the antilog scale, and a series of correction estimators have been designed precisely to achieve this. Using parameter landscapes, the performance of the correction estimators and several LFMs under different data residual shapes, sample sizes and coefficients of determination were explored. Predictions from the nonlinear LFM were found to have minimum MSR values (minimum bias), but with obviously skewed frequency distributions of the predicted Y-variable compared with observed data. This implies that using MSR as a bias measure for allometric prediction could be misleading. A new bias measure, the discrepancy of the frequency distributions of the Y-variable between predicted and observed data, is introduced in the work and it shows that the reduced major axis method is the least biased method in most cases, both on the logarithmic and antilog scales. Parameter landscapes clearly illustrate the performance of each LFM and correction estimator, as well as the best solution given specified criteria. The work concludes by suggesting a shift in emphasis from designing more sophisticated LFM or correction estimators (equal to finding the peaks in the parameter

landscape) to justifying the measure of bias and performance criterion in allometric prediction.

Empirical studies took a variety of forms to address the key areas identified in our Strategic Plan. For example, the way in which available energy of a form not typically considered, that is wind, might affect diversity, was investigated as part of our investigations of species-energy theory (Davies *et al.* 2010). Tests of the energy hypothesis for the large-scale distribution of species richness have largely been concerned with the influence of two alternative forms of environmental energy, temperature and energy from primary productivity, both of which (at least in terrestrial systems) peak within the tropics. Taxa showing extratropical diversity peaks present a potential challenge to the generality of species–energy theory. One such group are pelagic seabirds of the order Procellariiformes (Figure 8) that show not only an extra-tropical diversity peak but one confined to the Southern Ocean, hence a highly asymmetric one. They are distinct in being exceptionally adapted to take advantage of wind energy, which they may rely on for long-distance ocean foraging for the patchy resources needed to meet their energetic needs. Wind represents a readily available source of kinetic energy, shows a strong latitudinal gradient, and has been largely omitted from species–energy theory. Moreover, maximal benefits of wind are likely to be afforded in areas of greatest available contiguous ocean extent. We compare the relative importance of wind speed, ocean productivity (chlorophyll concentration), air temperature and available ocean extent (distance) in explaining large-scale global distribution of procellariiform species richness across the world's oceans. Hierarchical partitioning of non-spatial regression models indicates that ocean distance is the most important predictor of procellariiform species richness followed by wind speed and then temperature. In contrast, that of spatial regression models indicates the roughly equal importance of ocean distance and temperature, followed by wind speed. Although contributing additional model fit, ocean productivity is consistently the weakest predictor. Best-fit models include all four predictors and explain 67% of observed variation. The species–productivity relationship is negative overall, while the species–temperature relationship is hump-shaped. In contrast, ocean distance and wind speed are positively associated with species richness. Large-scale procellariiform species richness distribution may represent a trade-off in the use of different energy forms, being highest in Southern Ocean areas where productive energy and temperature are relatively low, but where available ocean foraging extent and wind energy required to utilize it are near-maximal.

Figure 8. Wandering albatross, the largest member of the Procellariiformes.

Two studies explicitly addressed explicitly the influence of spatial scale on species abundance and distribution. In the first, the influence of spatial scale (from 10 cm to 100 km) on assessments of mangrove pneumatophore arthropod community structure was examined (Proçhes *et al.* 2010). The study also determined whether resource availability or habitat were responsible for the spatial patterns in this mangrove inhabiting community. As predicted, spatial autocorrelation in most ecological variables decreased with increasing spatial scale (such that the values of ecological variables were more similar to each at closer positions in space than they were when further apart). The patterns differed for rare and common species and reflect the patchy distribution of pneumatophores within mangrove forests, that of the forests along the coast, as well as the poor dispersal abilities of most of the arthropods in the community in this highly dynamic environment. The work highlights the need for multi-scale and cross-scale studies to bridge the gap between understanding the determinants of ecological niches at fine scales and realized geographic range at larger scales.

Understanding the distribution and abundance of invasive alien species is essential for making management decisions to mitigate their impacts. Such data are commonly unavailable or incomplete. Veldtman *et al.* (2010) used scale–area curves (Figure 9) to estimate the distribution, abundance and consequent management implications for an invasive plant (*Acacia longifolia*). The study was conducted across the invasive range of the species in South Africa, with the aim of determining the extent to which the distribution is explained by climatic suitability or range structure. A further aim was to identify areas where *A. longifolia* can still be regarded as an important invasive species in the country. The quarter degree occupancy of *A. longifolia* was used to select core, edge, and climatically unsuitable grid cells within different regions of the national range. Cells were surveyed across a linear resolution from 25 km to 2.5 m, allowing the first multi-scale description of the 'space-filling' properties (or range structure) of an invasive species. In regions with continuous areas of favourable habitat, scale–area curves indicated greater occupancy by the species in core areas

(climatically most suitable) than edge areas, whereas patterns were reversed when suitable areas were more fragmented. Also, climatically suitable areas were sometimes not occupied, while areas predicted to be climatically unsuitable were occupied. Within geographic grid cells, occupancy was well explained by the presence of Fynbos vegetation types, whereas nationally the only continuous regions occupied by the species were in the Fynbos Biome. The study demonstrated that scale–area curves are useful for improving the understanding of species invasions. The study further detected potential areas where invasion by the species is a particular concern (i.e. areas where it appears that it is not being effectively controlled by its biological control agent). Because there was no general relationship between range position or climatic suitability and the range structure of *A. longifolia*, Veldtman *et al.* (2010) proposed that habitat suitability is an important local determinant of the distribution of this plant invader.

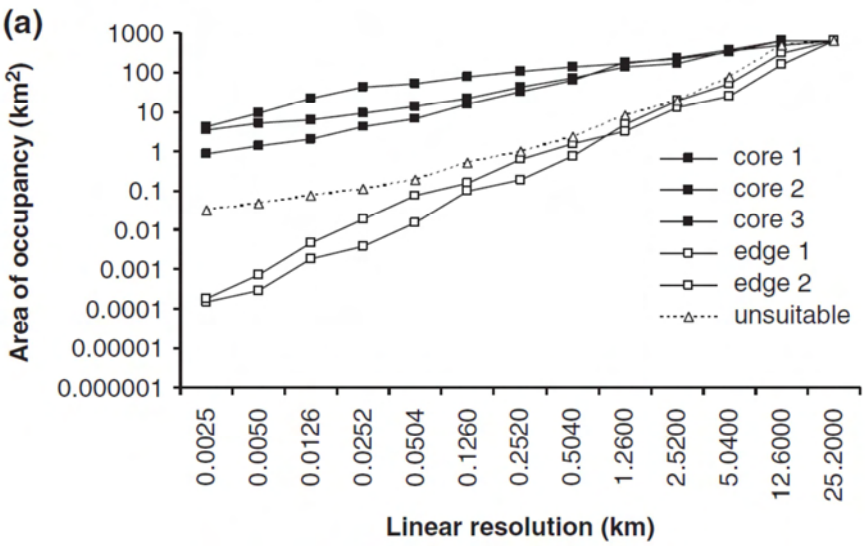


Figure 9. Scale area curves for *Acacia longifolia* in western South Africa. Gentle slopes are indicative of increasing populations and steep slopes of declining populations. The legend refers to the core of the species range, its edge or unsuitable cells according to an environmental niche model.

1.3.3 Molecular ecology and genetics of invasions

The C·I·B has greatly expanded its work in this field. Recent advances in molecular ecology offer exciting opportunities to gain fundamental insights on a range of processes relevant to biological invasions, and can help in the formulation of management strategies. Three projects that were completed in 2010 give a flavour of the exciting work in this field.

The house mouse (*Mus musculus domesticus*) was moved around the world by humans from its original range in Western Europe in historic times. However, the mice only reached most of the oceanic islands in the past three centuries. This makes them an excellent model for

studying evolutionary processes during the early stages of colonization. A study undertaken by an international team determined the history of colonization of the sub-Antarctic Kerguelen Archipelago and compared this with results from other Southern Ocean islands (Hardouin *et al.* 2010). They typed 18 autosomal and six Y-chromosomal microsatellite loci and obtained mitochondrial D-loop sequences for 534 samples, mainly from the Kerguelen Archipelago, but also from the Falkland Islands, Marion Island, Amsterdam Island, Antipodes Island, Macquarie Island, Auckland Islands and South Georgia. They found that most of the mice on the Kerguelen Archipelago have the same mitochondrial haplotype and all share the same major Y-chromosomal haplotype. Two small islands within the archipelago show a different mitochondrial haplotype, are genetically distinct for autosomal loci, but share the major Y-chromosomal haplotype. In the mitochondrial D-loop sequences, they find several single-step mutational derivatives of one of the major mitochondrial haplotypes, suggesting an unusually high mutation rate, or the occurrence of selective sweeps in mitochondria (Figure 10).

The results show that very few animals first colonized the main islands in the Kerguelen Archipelago (two mtDNA haplotypes and a single nuclear genotype meaning a minimum of two females and one male). The fact that low mitochondrial variation was detected means that these initial small numbers of animals quickly multiplied, and became so well adapted to the local conditions that they outcompeted (and essentially prevented) any further introductions (the assumption is that most of the earlier ships that arrived at Kerguelen carried mice, but that these essentially never established on the island because mice were already present there). On the other two smaller islands, mice are very different to those found across most of the islands including the main island, suggesting that a second introduction took place to these two islands (Cochons and Cimetière), rather than colonization from the main island.

Mice have been used as a surrogate model to track human movement, including both the early colonization and spread of humans as well as more recent movement during the past few centuries. As such, human movements across the Southern Ocean can be inferred by studying the patterns in these small rodents. The impact of mice on oceanic islands has also been catastrophic for local biodiversity, and today intervention is needed in many instances. Knowing the origin of these highly invasive animals provides valuable information for biological control programmes, should they be deemed necessary.

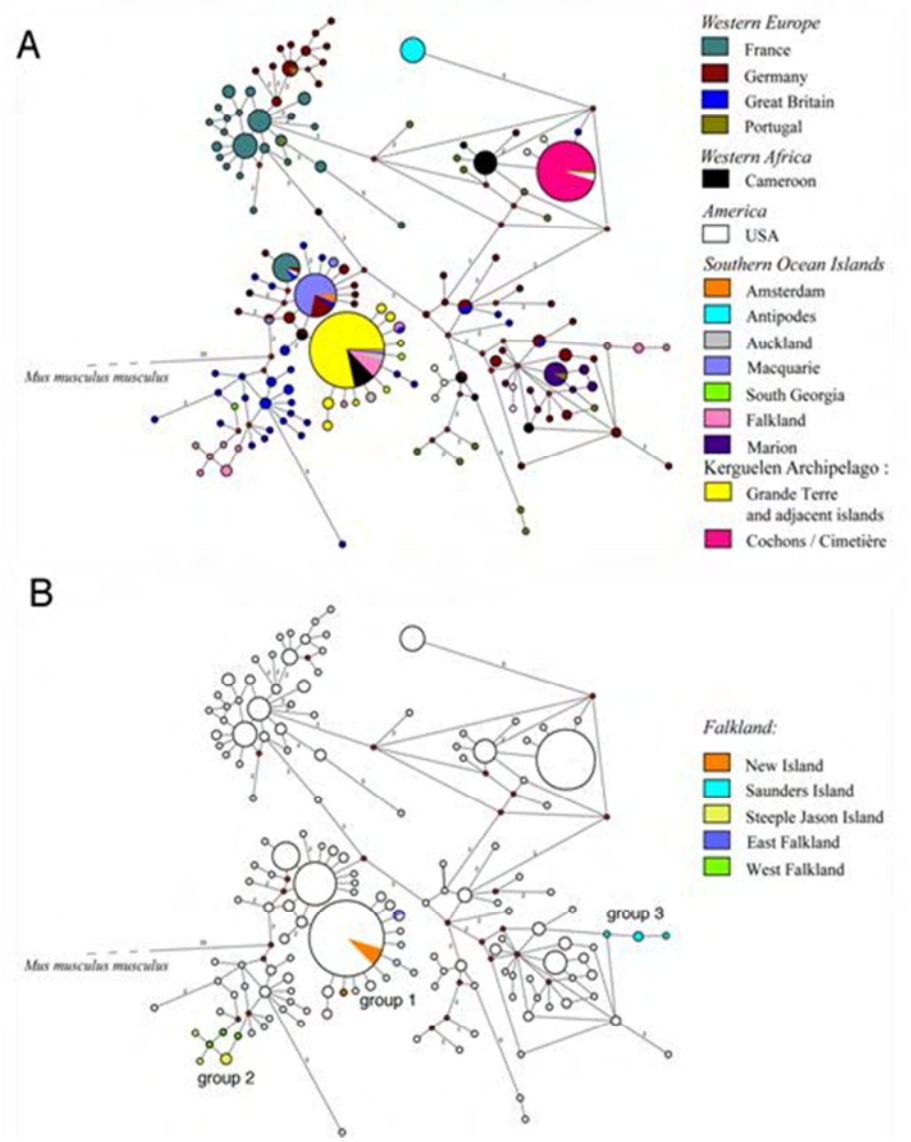


Figure 10. D-loop haplotype networks calculated using Median Joining for *Mus musculus domesticus* samples with *M. m. musculus* as outgroup. The size of the circles represents the frequency of the respective haplotype in our sample. Each node is one mutational step away from the next node; numbers indicate the cases where more than one step is required to join the nodes. Small red circles indicate branch splits. (A) General network including all published sequences that are related to the Kerguelen haplotypes. (B) Same network as in (A), but only with the Falkland samples highlighted.

Whilst dispersal is a critical factor for the success of introduced species, its quantification, especially for rare long-distance dispersal events, is notoriously difficult and time consuming (often impossible) to measure directly. This problem is exacerbated in sessile plant populations, especially for past dispersal events. Highly variable molecular markers now make it possible to quantify the movement and spatial distribution of alleles (gene flow), indirectly measuring dispersal as a function of individual, seed, and pollen movement. Using microsatellites Le Roux *et al.* (2010) described the movement and spread of the invasive plant *Senecio madagascariensis* (‘fireweed’, from South Africa). Their results showed that this

species utilizes a stratified dispersal mode whereby outlying foci (mostly human-mediated dispersal) act as sources for subsequent diffusion. They also illustrated that rare long-distance dispersal occurs between different islands in the archipelago. For example, in their study they identified populations on the island of Hawaii that originated from sources on the island of Maui, at least 150 km away (Figure 11). Furthermore, these two islands are separated by at least 75 km of ocean. Coupled with habitat suitability models the inferred patterns of dispersal were used to identify areas at risk of invasion by *S. madagascariensis*. Suitable habitats for fireweed invasions were identified on all of the seven main Hawaiian Islands, stressing the need to restrict its movement to Maui and Hawaii.

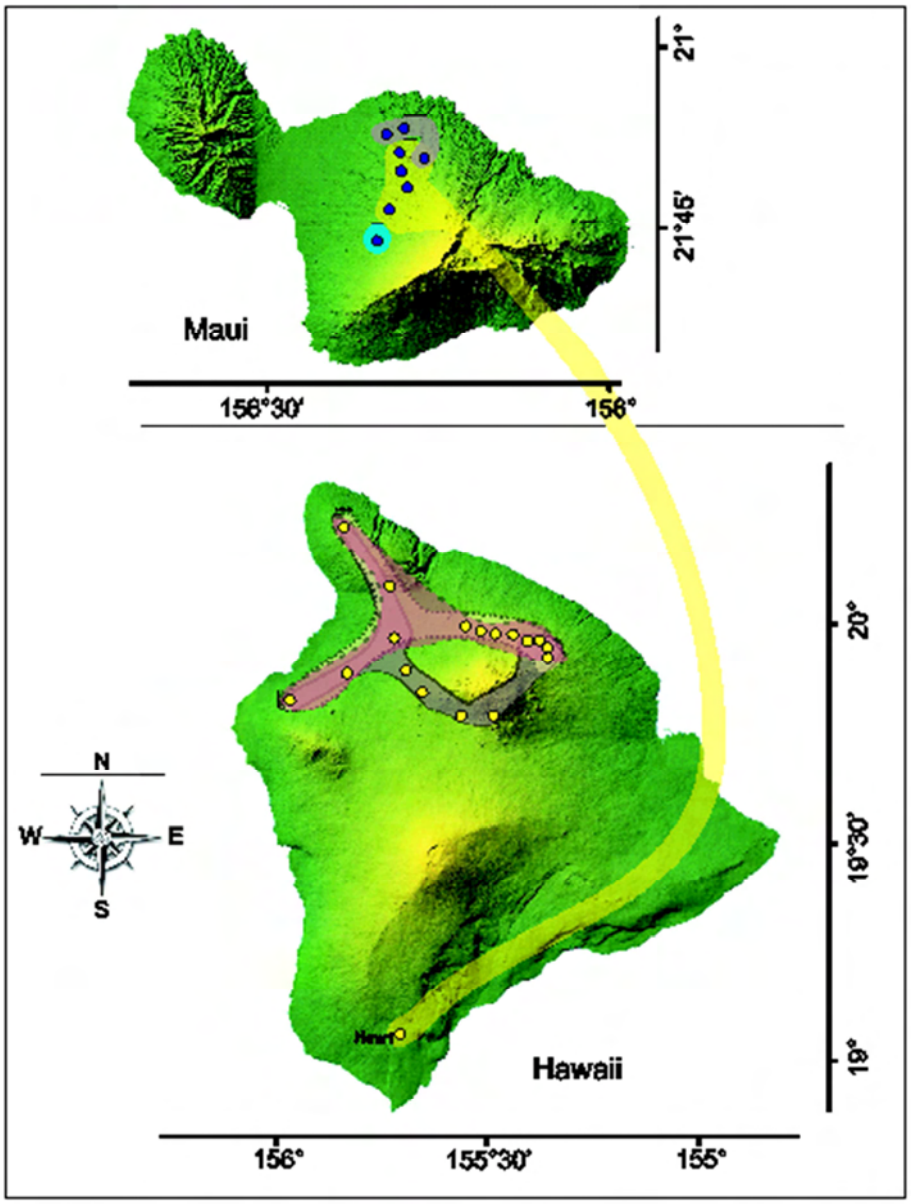


Figure 11. Genetic structure of *Senecio madagascariensis*. Similarly shaded polygons connect genetically similar populations (dots). Most polygons connect neighbouring populations, consistent with a diffusive dispersal pattern while some, e.g. the yellow polygon, connect very distant populations; genetic structure consistent with long distance dispersal.

Insights from genetic studies have important applications for guiding strategies for managing invasive species. Many plant species with commercial importance in horticulture are serious invaders. Molecular studies are sometimes essential for correctly identifying difficult taxa or determining genetic origins and relatedness of horticultural breeds and invading populations. Le Roux *et al*. (2010, *Biol. Inv*.) used a phylogenetic approach to identify species of Australian Kangaroo Paws (*Anigozanthos* spp.) that have naturalized at the edge of the Kogelberg Biosphere Reserve. After reconstructing a complete genus-level phylogeny, two species of kangaroo paws were recognized among the invasive populations*: A. flavidus* and *A. rufus*. It was previously thought that only *A. flavidus* is present in South Africa. Besides providing definitive identification of the invading species (which has been communicated to nurseries), the research revealed a positive relationship between relative genome size similarity and the reproductive fitness of hybrids among different species of *Anigozanthos*. These findings also have important implications for plant invasions in general. In the case of the two kangaroo paw species currently found in South Africa, genome size 'compatibility' and their pollination ecology suggest that hybridization is likely to occur in the field. Native bird species such as orange-breasted sunbirds are attracted to the flowers and nectar of Kangaroo paws and could easily facilitate cross-fertilization between *A. rufus* and *A. flavidus* (Figure 12). It is well known that hybridization between taxa can result in increased invasiveness.

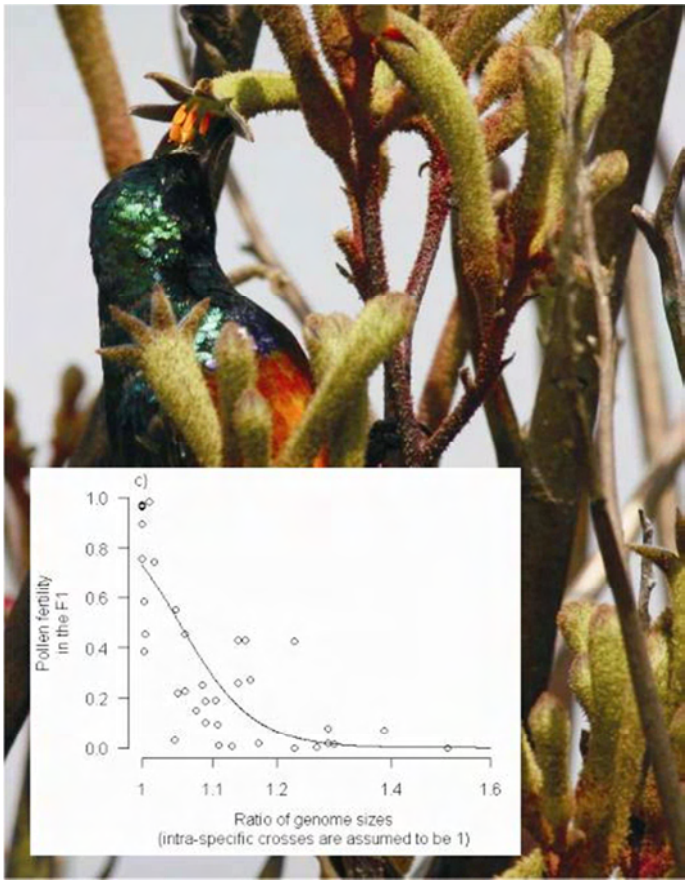


Figure 12. South African birds like the Orange-breasted Sunbird can facilitate cross-pollination between different *Anigozanthos* species – The inserted graph shows that when different species with similar sized genomes outcross they are more likely to produce fertile hybrid offspring

1.3.4 Global environmental change, biological invasions, ecosystem services and sustainability

The C·I·B's work on global environmental change drivers, and particularly interactions among them, is continuing to develop. In keeping with new developments, outlined in the Strategic Plan and also as part of our contribution to Stellenbosch University's HOPE project, we have expanded work from dealing largely with biological invasions, to assessment of all of the major drivers and interactions among them. For southern Africa, a key paper provides an overview of these drivers in the context of landscape transformation of the region (Chown 2010). The work, which was also presented at a Royal Society 350th anniversary symposium on biodiversity in a changing world, commences by demonstrating that landscape transformation by humans is virtually ubiquitous, with several suggestions being made that the world's biomes should now be classified according to the extent and nature of this transformation. Even those areas that are thought to have a relatively limited human footprint have experienced substantial biodiversity change. This is true of both marine and terrestrial systems of southern Africa, a region of high biodiversity and including several large conservation areas. Global change drivers have had substantial effects across many levels of the biological hierarchy as is demonstrated in the review, which focuses on terrestrial systems. These include ongoing reductions in diversity owing to landscape transformation, changes in the abundance and distribution of species as a consequence of climate change, pollution-related impacts especially on the avifauna but also on ecosystems generally, and non-intuitive homogenization affects owing to the movement of ungulates around the country (these latter impacts being larger than those documented and forecast under climate change scenarios). Interactions among drivers, such as between climate change and invasion, and between changing fire regimes and invasion, are complicating attribution of change effects and management thereof. Likewise CO_2 fertilization is having a much larger impact on terrestrial systems than perhaps commonly acknowledged. The study concludes by noting that temporal changes in biodiversity, and the seeming failure of institutional attempts to address them, underline a growing polarization of world views, which is hampering efforts to address urgent conservation needs.

The ways in which human endeavour has the potential to compromise biodiversity quickly, and with great cost of remediation, are further illustrated by an investigation of potential marine invasions at Tristan da Cunha Island (Wanless *et al.* 2010). A virtually intact subtropical reef community (14 phyla, 40 families and 62 non-native taxa) was associated with a rig under tow from Brazil that became stranded on this remote island. Clearly such rigs are significant vectors spreading alien marine organisms, and in the current case these include the first records of free-swimming marine finfish populations becoming established after unintentional movement. With relatively trivial effort, a pre-tow clean would have obviated the need to salvage and dispose of the rig (undertaken largely to address concerns about invasive species), at a cost of US$20 million. The findings show that towing biofouled structures across biogeographic boundaries presents opportunities for invasion to a wide diversity of marine species. Better control and management of this vector is required urgently. The distribution of intact populations of multiple marine organisms is a rare event, and a basic framework for rapid assessment of invasion risks of this kind is developed in the paper.

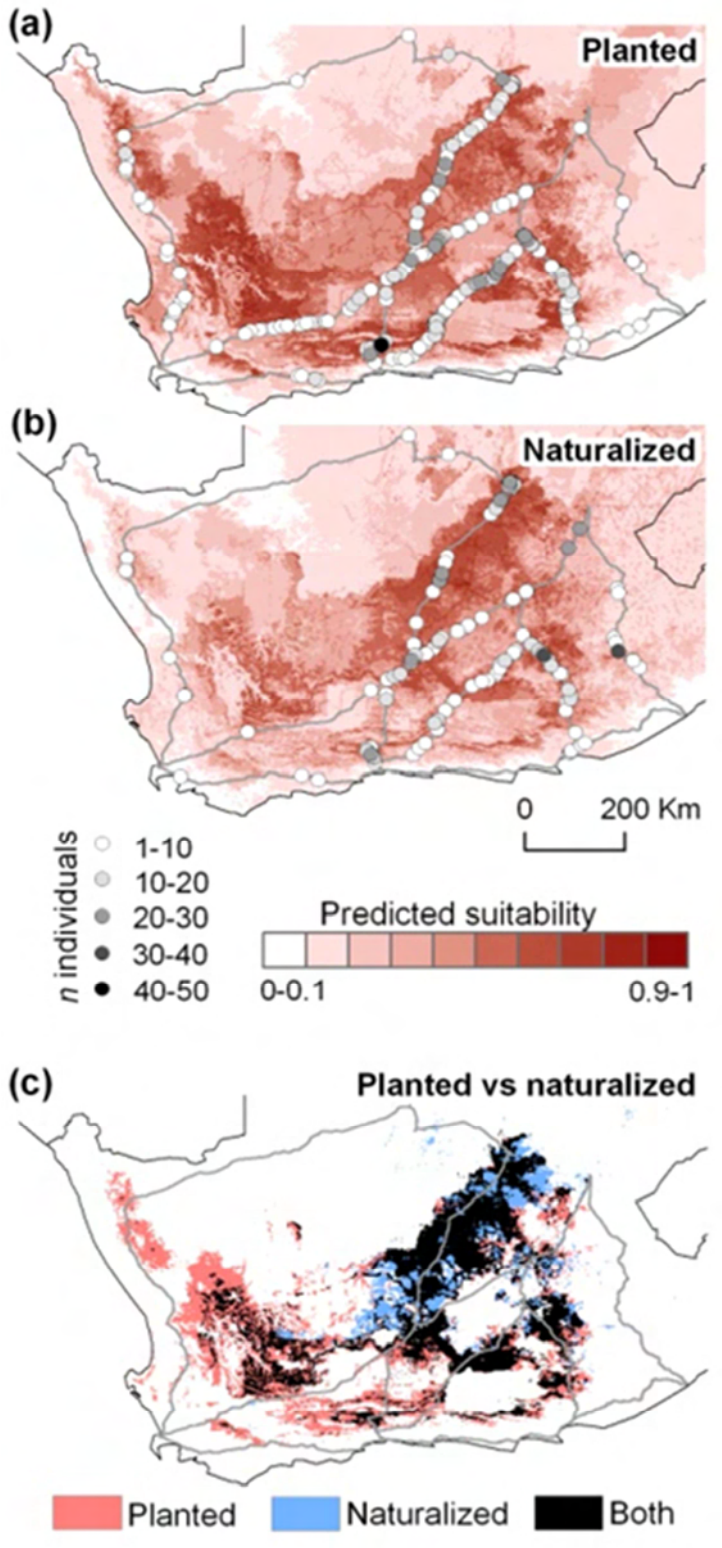


Figure 13. Predicted environmental suitability for the invasive tree *Schinus molle* modelled using locations of planted and naturalized individuals via boosted regression trees. Maps show the current predicted suitability for planted (a) and naturalized (b) individuals in each cell, and in panel (c) areas suitable only for planted (red), only for naturalized individuals (blue), and areas suitable for both (black).

Climate change may change the distribution range of invasive species, and tip the balance of interactions between invasive and indigenous species in favour of the former. The C·I·B is making substantial contributions here too. For example, the Peruvian pepper tree (*Schinus molle*; Anacardiaceae), is a long-lived, drought-tolerant, evergreen, dioecious tree native to the arid central region of South America. The species was introduced to South Africa in about

1850, and since 1950 has been widely planted, especially as a shade tree at picnic sites along major roads. In the last two decades it has become highly invasive in semi-arid savannas and is now listed as a major invader. Using combined niche modelling and fine-scale process-based modelling, Richardson *et al.* (2010) defined regions at high risk of invasion and simulated likely dynamics at the landscape scale. Localities of planted and naturalized trees were mapped along 5 380 km of roads – a transect that effectively sampled a large part of western South Africa. Profiles of present and future environmental conditions characterizing its planted and naturalized ranges were generated using correlative modelling. A cellular automaton simulation model was used to estimate the dynamics of *S. molle* under future climates and different management scenarios (Figure 13).

The overall potential range of *S. molle* in the region was predicted to shrink progressively with predicted climate change. Some of the potential range of *S. molle* defined based on current conditions (including areas where it is currently highly invasive) is likely to become less favourable. The species could persist where it is well established long after conditions for recruitment have deteriorated. Some areas where the species is not widely naturalized now (notably the Fynbos Biome) are likely to become more favourable. This modelling approach allows for the delineation of areas likely to be invaded in future by considering a range of factors at different scales that mediate the interplay of climatic variables and other drivers that define the dimensions of human intervention such as distance from planted trees and the density of planted plants, both of which affect propagule pressure.

The interaction between climate change and invasion was also examined for soil organisms (specifically springtails or Collembola) in the terrestrial system at Marion Island. This work not only forms a contribution to ongoing research in the Antarctic region by the C·I·B, but also a growing capability in soil ecology focussing specifically on this group. In particular, the study in question (Janion *et al.* 2010) examined how the impacts of climate change on biological invasions will play out at the mechanistic level, an area that is not well understood. Two major hypotheses have been proposed: invasive species have a suite of traits that enhance their performance relative to indigenous ones over a reasonably wide set of circumstances; invasive species have greater phenotypic plasticity than their indigenous counterparts and will be better able to retain performance under altered conditions. Thus, two possibly independent, but complementary mechanistic perspectives can be adopted: based on trait means and on reaction norms. To demonstrate how this approach might be applied to understand interactions between climate change and invasion, egg development times and their sensitivity to temperature amongst indigenous and introduced springtail species in a cool temperate ecosystem (Marion Island, 46°54’S 37°54’E) that is undergoing significant climate change were investigated. Generalized linear model analyses of the linear part of the development rate curves revealed significantly higher mean trait values in the invasive species compared to indigenous species (Figure 14), but no significant interactions were found when comparing the thermal reaction norms. In addition, the invasive species had a higher hatching success than the indigenous species at high temperatures. This research demonstrates the value of explicitly examining variation in trait means and reaction norms among indigenous and invasive species to understand the mechanistic basis of variable responses to climate

change among these groups. It also shows that much variation may exist among traits in the extent of plasticity. For the same group of species it was shown that the invasives generally show lower rates of water loss (and this greater resistance to desiccation) than their indigenous counterparts. In consequence, warming and drying at the island will increase fitness in the invasive species and depress it in the indigenous ones.

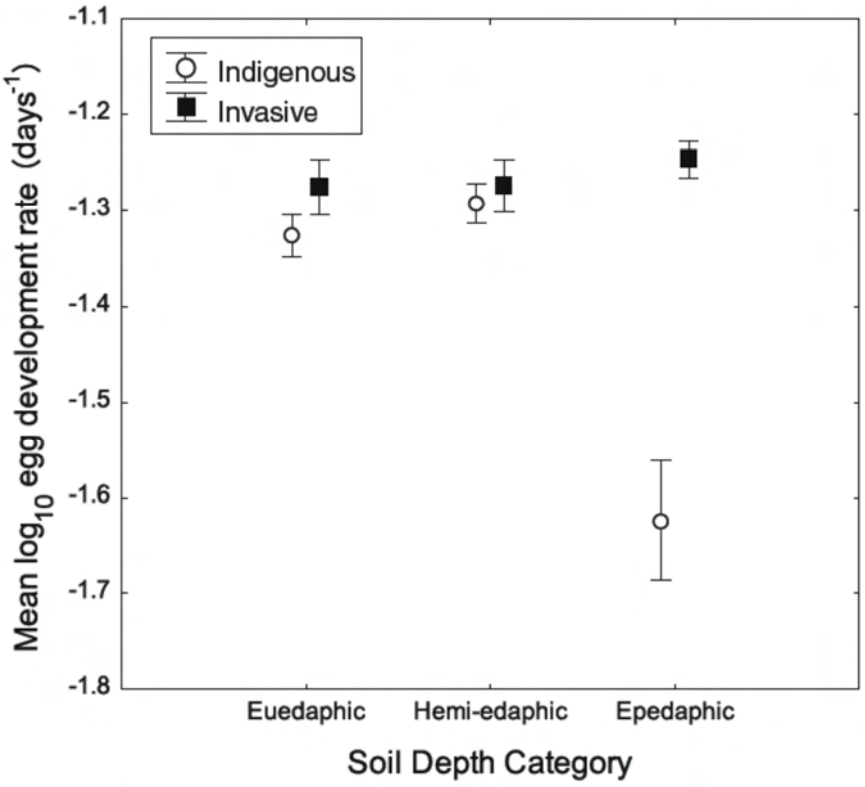


Figure 14. The effect of depth distribution and species' status (indigenous vs. invasive) on the mean egg development rates of seven species of springtails found on Marion Island. Notice the generally low rates for the indigenous species compared with the invasives.

Of course, the impacts of invasive species amount not only to those on biodiversity, but also to those on economic well-being, either via the impacts on biodiversity or on ecosystem services, or on economic activities (such as farming) directly. Quantifying these costs and the values of mitigation actions such as biological control is of exceptional importance for understanding the economic consequences of invasions and the benefits that accrue from both actions to reduce their impacts and the underpinning research. A recent work has done so especially for biological control (de Lange and van Wilgen 2010). The evaluation focussed on the delivery of ecosystem services from habitats that are invaded by groups of weeds, rather than by each individual weed species. The net present value of the weed biological control efforts was established, and benefit:cost ratios derived by comparing this value (a cost) to the estimated value of ecosystem services protected by weed biological control. Four major

functional groupings of invading alien plants were identified, and their impact on water resources, grazing and biodiversity assessed.

The study estimated the area that remained free of invasions due to all historic control efforts in South Africa, and the proportion that remained free of invasion as a result of biological control (which was initiated in 1913). The estimated value of potential ecosystem services amounted to R 152 billion (presently, about US$ 19.7 billion) annually (Table 1). Although an estimated R 6.5 billion was lost every year due to invading alien plants, this would have amounted to an estimated additional R 41.7 billion had no control been carried out, and 5-75% of this protection is due to biological control. The benefit:cost ratios ranged from 50:1 for invasive sub-tropical shrubs to 3726:1 for invasive Australian trees. Benefit:cost ratios remained positive and the conclusion, that biological control has brought about a considerable level of protection of ecosystem services, remains robust even when our estimates of the economic impacts of key variables (i.e. sensitivity analyses of indeterminate variables) were substantially reduced. These results demonstrate the enormity of the economic burden that is placed on South Africa by a single group of invasive species (recall that invasive animals are excluded from the study), and the tremendous value that has been derived from interventions that are underpinned by sound research.

Table 1. Estimated net present values (in R millions) of ecosystem service benefits attributable to biological control of four groups of invasive plants in five biomes in South Africa.

Biome	Fire-adapted trees	Invasive Australian trees	Invasive succulents	Subtropical shrubs
Fynbos	528	28,863	35	<1
Grassland	93	49,363	1,506	729
Succulent Karoo	12	1,177	26	0
Nama karoo	0	12,713	1,558	0
Savanna and thicket	207	12,005	34,089	1,833
Total	840	104,122	37,215	2,562
Benefit:cost ratio	81:1	3,726:1	2,731:1	50:1

Benefit:cost ratios compare the net present value (at 8% discount rate) of benefits to the net present value of the costs of biological control

1.3.5 Detection, deterioration, restoration, reintroduction

A considerable body of work at the C·I·B explores the ecology of invasions. Among the many facets that are examined are patterns and processes leading to invasions, how invasions cause impacts in ecosystems, and the wide range of options for addressing impacts. Research has focussed on many taxa and types of ecosystems, and published products have included review papers, field surveys and experimental work, and various modelling studies. A major initiative was launched as part of the collaboration between the C·I·B and Working for Water to address a range of concerns relating to invasions by Australian *Acacia* and *Eucalyptus* species. Publications on this work will start appearing in 2011.

Several analyses were carried out to derive new insights on invasion dynamics. A review paper dealing with *Invasive species, environmental change and management, and ecosystem health* was published in the journal *Annual Review of Environment and Resources* (Pyšek and Richardson 2010). This contribution provided an outline of why invasions happen, and used the framework emerging from this to discuss stages of invasions and provide objective guidelines for prioritization for management intervention. The impact of invasive species was placed in context within the domain of environmental change. Ecological consequences of invasions, impacts on ecosystem services and human health were discussed. Problems associated with the recognition and measurement of ecological and economic impacts as a basis for management were discussed. The foregoing issues provided the foundation for a discussion of key management issues facing managers of biological invasions: risk assessment, pathway and vector management, early detection and rapid response, eradication, and mitigation and restoration. The paper ended with a critical discussion of the need to focus on management targets. Because of the complexity of the driving forces of invasions and the impacts they generate, invasion science is becoming increasingly intermeshed with a range of associated disciplines (Figure 15).

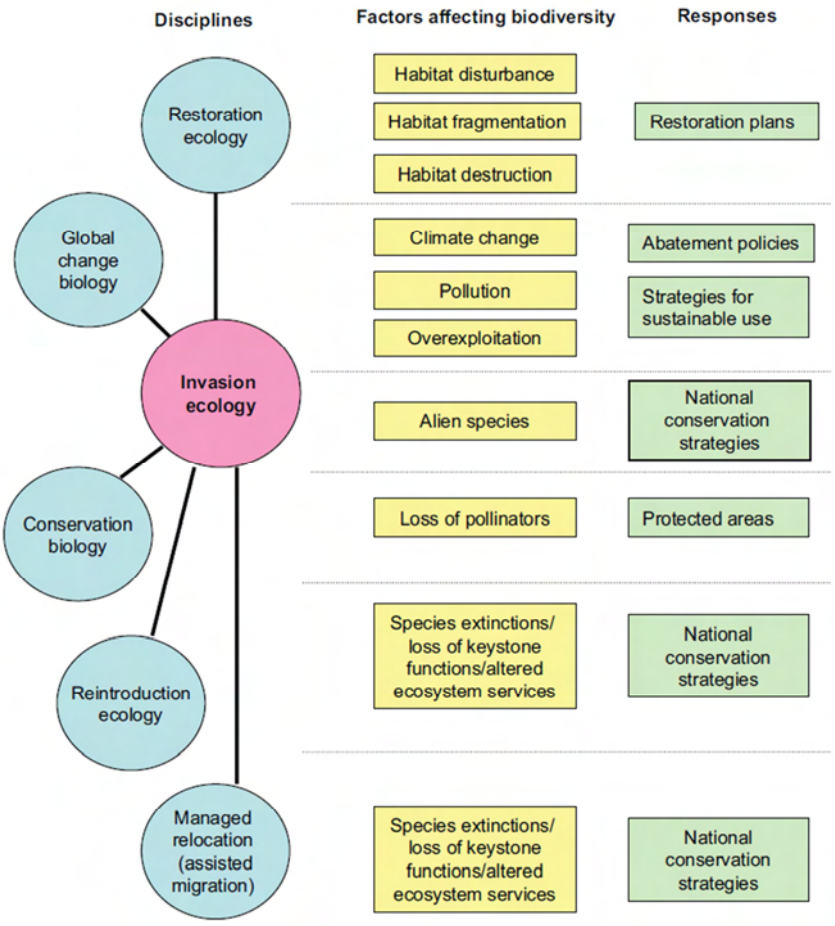


Figure 15. The field of invasion ecology is increasingly drawing insights from (and lending some to) other disciplines that have themselves evolved in response to challenges in biodiversity conservation.

Are plant invasions in African savannas just under-studied or are invasions really less severe than in savannas on other continents? A wealth of information exists on African savannas in several books and thousands of scientific articles. However, very little mention is made of plant invasions in most texts. In contrast, there is substantial body of literature on invasive plants from the Neotropics, and long lists of alien plants have been reported from the Australian savannas. Although invasive plants are not considered the main threat to tropical savannas and grasslands currently, they were predicted by the Millennium Ecosystem Assessment to become more problematic in future. The C·I·B undertook a major review of the literature to examine the situation in African, Australian and Neotropical savannas with respect to plant invasions (Foxcroft *et al.* 2010). The sparse information on plant invasions in Africa savannas suggests that they are not as great a problem as in savannas on other continents. However in southern Africa, where the most information is available, nearly 600 naturalised alien plants have been introduced, a substantial number of them being invasive. Other than the 40 species recorded in Uganda and Tanzania, little is known about invasions in the rest of Africa. African C_4 grasses such as *Hyparrhenia rufa*, imported into Neotropical savannas to improve forage quality, have spread widely causing significantly reduced native plant diversity and have increased fuel loads by 50%. African bunch grasses, such as *Andropogon gayanus* (Gamba grass), and European annual grasses have been widely planted over many decades as part of the Australian Commonwealth Plant Introduction scheme. One of the most severe impacts has been from Gamba grass which has developed a positive feedback loop by inhibiting nitrification, depleting total soil nitrogen from the already nitrogen-poor soils and promoting fire mediated nitrogen loss, thus outcompeting native species. The paucity of information on alien plants in Africa compared to the well documented cases in Australia and the Neotropics could be because: 1) Plant invasions have simply been poorly studied in African savannas; 2) African savannas are more resistant to invasions; or 3) most likely both of these reasons. Four factors appear to be important in the invasion of alien plants in Africa. African savannas have co-evolved with large numbers of a wide variety of herbivores, which could conceivably suppress the establishment of alien plants. However, large mammalian herbivores and the associated disturbance have long been absent from other savanna systems. Introductions and widespread pasture planting is strikingly different between the Neotropics, Australia and Africa. Pasture improvement by introduction and widespread dissemination of alien grasses has been practiced for a long time in Australia and the Neotropics. The biogeography and physiology of species that have been introduced is likely to have played an important role. Although CAM photosynthesizing Cactaceae have been introduced into Africa and Australia, it has not been at the same rate as the introduction of African C_4 grasses to Australia and the Neotropics. Moreover, the physiological adaptations of C_4 grasses make them highly competitive. Fire probably plays an important role as well. African savannas have co-evolved with, and have been shaped by, relatively frequent fire. This may suppress invasion of plants, while these grasses when

introduced into Australian and Neotropical savannas are able to successfully compete under the fire regimes, and even form self-reinforcing feedback loops.

The review showed that African savannas have been neglected and that comprehensive surveys and assessments of plant invasions are urgently needed. It also suggested some factors that might play a role in minimizing invasions; for example importation and dissemination of forage species. These unique factors can be used in advising policy to prevent and minimize the introduction and spread of alien plant species.

A critical challenge in managing invasive alien plants is the prioritization in the allocation of resources to control measures. Managers need to decide which species to focus on and where and they have to select the best possible approach to take from the range of management options available (e.g. mechanical clearing, the application of herbicides, burning, and biological control). Little is known of how such prioritization exercises have affected the distribution and density of invasive plants over time. The outcomes of integrated control of the invasive shrub *Hakea sericea* over four decades in South Africa were assessed in a recent study (Esler *et al.* 2010). This aggressively invasive shrub native to south-eastern Australia is a widespread invader in the Cape Fynbos, and occurs mainly in rugged, inaccessible and fire-prone mountain areas. The species is serotinous (i.e. has a canopy-stored seed bank), and produces copious amounts of seed that are wind dispersed after fires. After its naturalization in 1883, *H. sericea* spread to an area of 800 x 200 km. A survey in 1979 estimated the total area occupied by this species to be about 530 000 hectares. Twenty-two years later after an extensive survey by the Protea Atlas Group, the overall distribution of the species had declined by 64% to ~190 000 hectares. In the interim, control measures were introduced and included a combination of felling and burning, augmented by biological control. The initial programs of mechanical clearing initiated in the 1970s were largely responsible for reducing the density and extent of infestations, and biological control was largely responsible for the failure of the species to re-colonize cleared sites, or to spread to new areas following unplanned wildfires. The authors propose that a significant portion of the resources used for clearing *Hakea* in the past can now be reallocated to mechanical control efforts against other invasive species (such as alien pines) for which effective biological control options are not available. A *proviso* to this recommendation is that adequate resources are made available to ensure the widespread and effective implementation of all biological control agents so that the advances on the control of this species are maintained.

Riparian habitats are among the most highly degraded of habitat types in South Africa. Riverine ecosystems in the south-western part of the Western Cape are particularly degraded. Very few ‘natural’, or even ‘semi-natural’, vegetation communities remain in the lowland parts of this region. Riparian habitats are important for the sustainable delivery of key ecosystem services provided by rivers. For example, riparian vegetation communities anchor

river banks, preventing erosion, and provide essential habitat for a wide range of wildlife species, in some cases providing corridors for the movement of animal species across otherwise inhospitable tracts of human-modified landscapes. As is the case in many parts of the world, riparian ecosystems in the Western Cape have been heavily invaded and disrupted by invasive alien plant species. Meek *et al.* (2010) explored the relationships between human usage and land use history and the distribution and status of alien plant species along the full length of the Eerste River in the Western Cape. The river forms an appropriate example of a river system in a Mediterranean-climate region, with a relatively pristine upper catchment, but with heavy levels of transformation due to a range of anthropogenic activities in the lower reaches of the river. The river runs through Stellenbosch, and the investigation is an important part of baseline research aimed at establishing the Eerste River as a long-term study site for future work at the C·I·B.

Vegetation plots were sampled along the entire length of the river from headwaters to estuary (ca. 40 km). Plant community composition was analyzed in relation to land-use data collected in the field, and additional land-use variables computed from digital land-cover data. Patterns of plant community structure were found to be directly related to land use, with measures of cover, richness, and diversity differing significantly among land-use types. Portions of the riparian zone adjacent to agricultural land had the greatest level of alien plant cover, while areas bordered by urban land maintained the highest alien species richness (Figure 16). Areas adjacent to grazing and natural lands showed intermediate and low levels of invasion, respectively. Several native species were found to persist in areas with high abundance and diversity of invasive alien plants, suggesting that they will be valuable focal species for future restoration attempts. Due to the level of human-mediated change in many areas of the riparian zone, restoration to historic conditions over most of the river is not considered feasible. These areas should be recognized as examples of novel ecosystems, and management efforts should focus on restoring or creating desirable ecosystem functions, rather than on achieving assemblages comprising only native species.

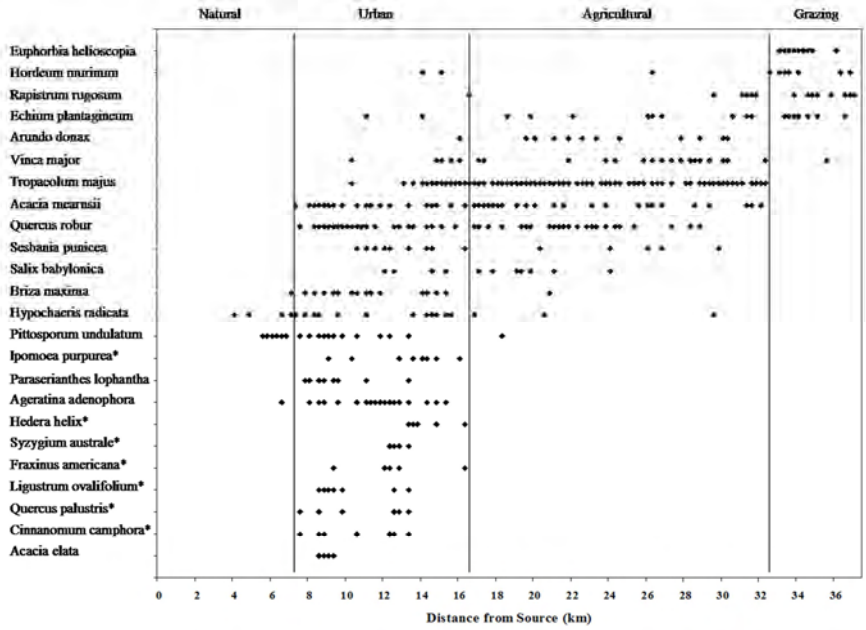


Figure 16. Distribution of some common alien plant species along a gradient of land use types adjacent to the Eerste River, Western Cape, South Africa. Species marked with (*) are primarily ornamental and garden species. Occurrence of species is represented by (♦).

Freshwater ecosystems in the Cape Floristic Region are also hotspots for fish invasions. In this region, introduced fishes, specifically black bass (*Micropterus* spp.) from North America, trout (*Salmo trutta* and *Oncorhynchus mykiss*) from Europe and North America and sharptooth catfish (*Clarias gariepinus*) from elsewhere in South Africa, are recognised as the most serious threats to the endemic fishes of the region by the current IUCN Red Data Listing. At a global scale, most Mediterranean-climate regions are also recognised as being hotspots of freshwater fish invasions. Marr *et al.* (2010, *Divers. Distrib*) highlighted the extent of freshwater fish introductions in five regions of the world with a Mediterranean-type climate: California, central Chile, south-western Australia, the southwestern Cape of South Africa and the Iberian Peninsula (Figure 17). The authors conducted a regional-level analysis of freshwater fish introductions, and collated species presence-absence data for native and non-native fishes across the five regions.

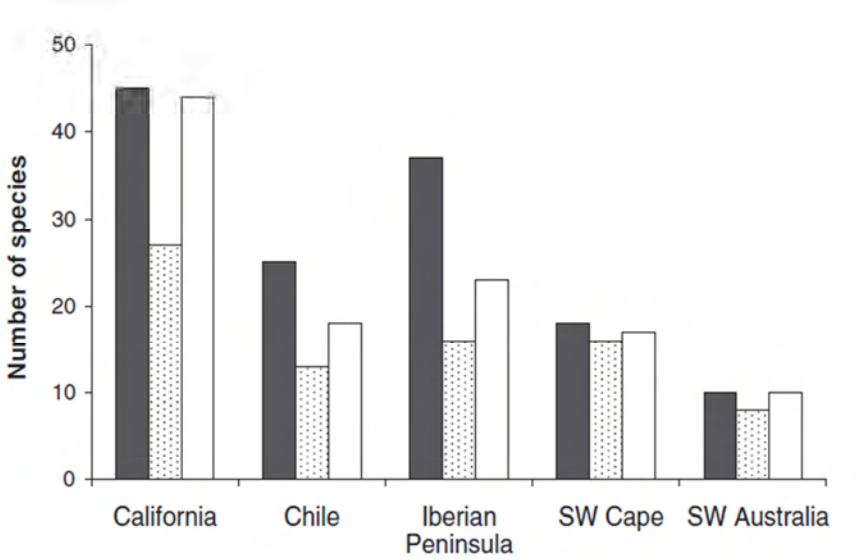


Figure 17. Number of freshwater fish species native (solid bars), endemic (stippled bars) and successfully introduced (open bars) to five Mediterranean regions.

Taxonomic patterns in freshwater fish introductions were evaluated by comparing the number of species introduced at the level of taxonomic orders to the numbers expected from a random sample of the global species pool. The authors also assessed factors that may have influenced multiple introductions of freshwater fish species in Mediterranean-climate regions. High levels of endemism, from 70 to 90%, were found for the south-western Cape, south-western Australia and Chile. Despite such high rates of endemism, all regions currently have more non-native species than endemic ones. Ninety percent of non-native species in these regions belong to five taxonomic orders, with Salmoniformes (trout and salmon) being significantly over-represented in all regions. In the south-western Cape, the Perciformes (bass and cichlids) were also over-represented. Interestingly, these two orders consist mainly of species introduced for recreational angling and aquaculture. Previous introduction success and latitude of the source region (as a proxy for net primary productivity) were the best predictors of whether a species will be widely introduced in Mediterranean-climate regions. This study showed that fish introductions in Mediterranean-climate regions are largely driven by taxonomically-biased human interests in recreational fisheries, aquaculture and pet species. It also underscored the importance of managing current non-native fish populations and preventing further introductions. While it is acknowledged that there are valuable recreational fisheries based on non-native species, the majority of involved parties (aquaculture practitioners, recreational anglers, hobby aquarists) are unaware of the long-term impact of non-native fish introductions. Improved conservation planning and education will be vital to the long-term conservation of native freshwater fish communities and the appropriate strategy will be context dependent.

Several species are emerging as important model species for a range of studies on different aspects of invasions. One of these is fountain grass *Pennisetum setaceum*. Invasive alien grasses from around the world are a common sight in many southern African ecosystems, especially in disturbed sites, riparian zones and along roads. In some cases, rivers and roads can act as corridors along which invasive alien species gain access to natural ecosystems. Several research papers have considered the role of roads and rivers as ecological 'corridors' for the dispersal of alien invasive grasses, although most of these treated rivers and roads separately, and without looking at how these features can hasten the invasion process. Rahlao *et al.* (2010) studied the effects of the interchanges between road bridges and rivers in the invasion success of fountain grass. The spread of this grass species, a Category-1 invader in South Africa, is attributable to its drought resistance, unpalatability to animals, rapid growth and prolific seed production. To determine the effects of river-road interchanges on the performance and abundance of fountain grass, the researchers set out to record and map the distribution of the species along 5 112 km of national roads in South Africa. They found the grass at 10% of the total road length sampled, especially in Fynbos (41%). Although the occurrence of the grass did not depend on the presence of river-road interchanges, its growth and reproduction performance were more vigorous at these interchanges than at areas away from these features. Several factors could make grass grow and reproduce better at river-road interchanges. Management activities, such as mowing and ditch excavation create disturbances which make the soil more suitable for colonization. A second consideration is the condition of the materials used in roadside construction. Soils transported from elsewhere may be unsuitable for indigenous species, leaving the area open for invasion by this grass and other weeds. Moisture and perhaps nutrients are more continuously available at these interchanges. In addition, river-road interchanges are often just outside the roadside management area, so that grasses which successfully establish there can continue to grow for years. The authors suggest that the presence of this weed along roadsides poses a major problem by facilitating invasion of natural areas. Since small populations of *P. setaceum* at river-road interchanges may lead to the spread through these corridors over the landscape, their early detection and control is important. To prevent the spread of this invasive alien grass, management should consider road-river interchanges as important targets for regional prevention and control efforts. Much further work is being planned on a range of aspects relating to fountain grass.

Another group of species that continues to enjoy considerable attention from C·I·B -affiliated researchers is dragonflies, insects belonging to the order Odonata. Dragonflies have proved to be very useful as indicators of ecosystem health. Invasive alien trees can be a major threat to river biodiversity. As dragonflies are very sensitive to these alien trees, the response of these insects to large-scale restoration of riparian corridors was assessed (Samways and Sharratt 2010). Three types of disturbance regime were compared: alien-invaded, cleared of alien vegetation, and natural vegetation as a control. Dragonfly responses were correlated with 22

environmental variables, with percentage bank cover and tree canopy cover being important. This highlights the importance of restoring appropriate marginal vegetation and sunlit conditions. Recovery of dragonfly assemblages in response to tree clearing was substantial, with species richness and abundance at restored sites matching those at natural sites. Dragonfly assemblage patterns reflected vegetation succession, with eurytopic, widespread species being the main beneficiaries of initial alien clearing, and stenotopic, endemic species appearing when indigenous vegetation recovered. The Indicator Value method showed two endemic species, *Allocnemis leucosticta* and *Pseudagrion furcigerum* as potential indicator species, in addition to the visually obvious vegetation, for monitoring return of overall riparian ecological integrity and for making management decisions. The important point is that the endemic species as a whole responded positively to restoration, suggesting that vegetation recovery has major benefits for the irreplaceable fauna as well as for widespread generalists (Magoba and Samways 2010).

Managing invasive species is one of the most taxing challenges facing conservation managers in many parts of the world. Because effective management of invasions requires cognisance of so many interacting factors (ecology of different invasions species, disturbance regime, political and management constraints, public opinion, etc.), managers are often overwhelmed by the complexity in their attempts to accommodate multiple linkages. Under these circumstances, multi-criteria decision models appear to be an appropriate tool for combining social, economic and environmental factors into a manageable number of factors to identify an optimal management strategy. These models are, however, not exempt from uncertainties due to the use of inappropriate factors. The emerging field of conservation biogeography seeks to apply biogeographical principles, theories, and analyses to problems concerning the conservation of biodiversity. Roura-Pascual *et al.* (2010) conducted a spatially-explicit sensitivity analysis (by applying three different approaches) to assess the spatial implications of changing the relative importance of factors included in a multi-criteria decision model aimed at prioritizing areas for clearing invasive alien plants in South Africa's Cape Floristic Region. The study revealed that priority maps were most sensitive to the fire-related factors, suggesting that fire is both a crucial driver of invasion in Fynbos and an overriding determinant of management options. The sensitivity of the model to changes in other factors was more context-specific. An important finding was that the prioritization of areas for alien clearing is highly dependent on the particularities of the regions of study, and the development of general guidelines across regions within the same bioregion is limited. Consequently, prioritization strategies need to be adjusted to the environmental conditions and status of invasions of each region. The adoption of different prioritization approaches has considerable consequences at a spatial prioritization level, and managers need to be aware of their decisions when setting priorities for alien control.

Invasion ecology is becoming increasingly intermeshed with restoration ecology, as invasive species become an increasingly significant contributor to habitat degradation worldwide. Many ecosystems have been transformed, or degraded by human use, and restoration offers an opportunity to recover services and benefits, not to mention intrinsic values. An international team (Aronson *et al.*, 2010) assessed whether restoration scientists and practitioners use their projects to demonstrate the benefits restoration can provide in their peer-reviewed publications. The team evaluated a sample of 1 582 published papers on restoration to determine whether links are made explicit between ecological restoration, society, and public policy related to natural capital. The study found clear evidence that restoration practitioners are failing to signal links between ecological restoration, society, and policy, and are underselling the evidence of benefits of restoration as a worthwhile investment for society. Clearly this is an area requiring attention from invasion ecologists and restoration ecologists.

1.3.6 Risk assessment indicators and policy

Invasive alien species are generally accepted as being one of the top three threats to biodiversity worldwide, but until now there has been no metric for assessing the magnitude of the problem globally, its impact and our responses to it. In McGeoch *et al.* (2010) a set of four indicators are derived that enable us to monitor changes in the extent and magnitude of invasions and their impacts, and to assess the extent to which policy responses are addressing the problems (Figure 18). The study is an important contribution to the Convention on Biological Diversity's 2010 Biodiversity Target. The research shows that we are significantly underestimating the size of the invasion problem, because the majority of countries have inadequate data on even the identity of invasive alien species present in the country. A strong link also exists between economic development and a country’s capacity to manage the invasive alien species problem. This emphasizes the importance of integrating poverty alleviation and conservation agendas. The work further shows that invasive alien species are having a net negative impact on biodiversity.

Red List Indices show that the extinction risk of birds, mammals and amphibians is increasing over time (as shown by the movement of species through categories on the IUCN Red List). Although some threatened species have improved in status (and been downlisted on the IUCN Red List) as a result of successful control or eradication of invasive species, more have been uplisted owing to increasing spread and threats from invasive species (examples are given in the paper). Policy responses have been in the right direction — there are now ten international conventions and agreements with provisions for tackling invasive species, and over 80% of eligible countries have signed up to these. Only slightly more than half of countries have national legislation for tackling the problem. Even fewer have cohesive strategies and implementation plans for on-the-ground-management. On a positive note there has been an exponential increase in countries becoming signatory to international agreements relevant to controlling invasive alien species since the 1970s, with the large majority of countries signatory to more than one such agreement. There is also clear evidence of improvement in the conservation status of selected species as a direct consequence of actions to control invasive alien species. Finally, the cost associated with the impact and control of invasive

alien species appears to far exceed the cost of the investment required for research and prevention.

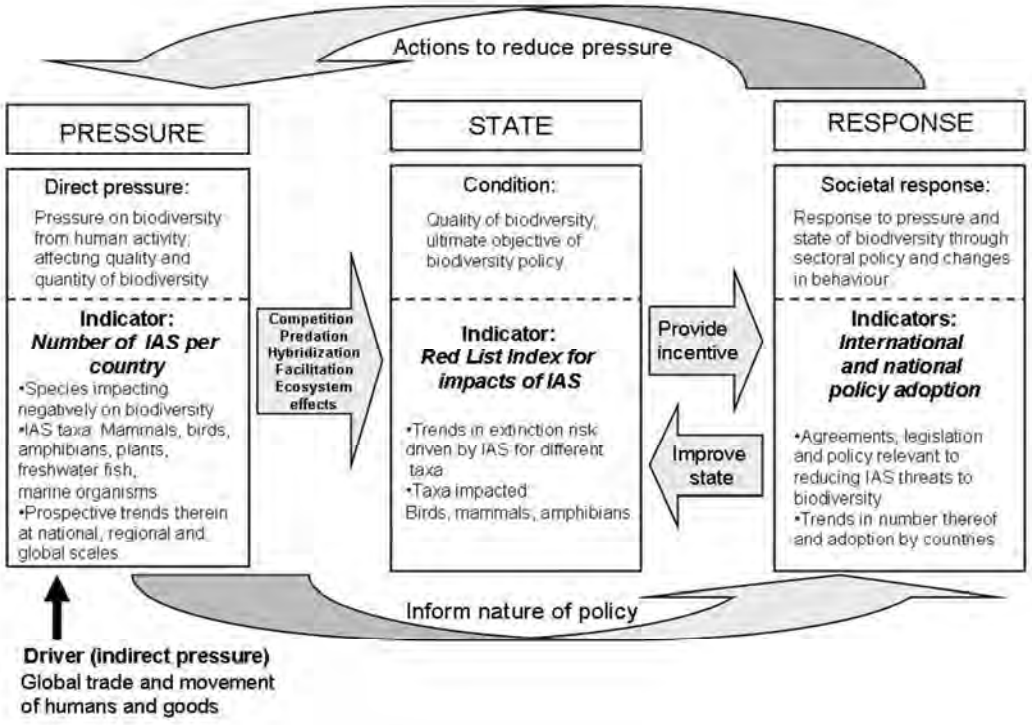


Figure 18. Pressure-state-response model of the invasive alien species (IAS) indicators for reporting on the 2010 Biodiversity Target.

In 2002, world leaders committed, through the Convention on Biological Diversity, to achieve a significant reduction in the rate of biodiversity loss by 2010. To know if this '2010 Biodiversity Target' had been met, it was necessary to collate information across a range of globally representative indicators that provide information on the status of, and trends in, global biodiversity. Butchart *et al.* (2010) compiled 31 such indicators to report on progress toward this target. The indicators selected were those that provided the most robust, scientifically well-supported information and the longest available time series. This research also provides the first comprehensive global assessment of the state of biodiversity. A pressure-state-response model was used, which provides information on the state of biodiversity, the pressures on it, as well as our response to biodiversity loss via policy and management (Figure 19). The indicators selected included information on species populations, species extinction risk, habitat degradation and loss, nitrogen pollution, biological invasion, human resource use and overexploitation, climate change impacts on biodiversity, sustainable forest management, extent of protected areas, policy responses and biodiversity-related aid. Most indicators of the state of biodiversity showed declines over the past four decades, with no significant recent reductions in rate of biodiversity loss (Figure 19A). At the same time indicators of pressures on biodiversity mostly showed increases, and the trend in such pressures was positive (Figure 19B). Despite some local successes and

increasing responses by humanity to this biodiversity crisis (Figure 19C), the rate of biodiversity loss does not appear to be slowing.

Indicator development has improved substantially since the 2010 target was set. However, there are still considerable gaps in geographic, taxonomic and temporal coverage of existing indicators. More is known about trends in the state of biodiversity than about pressures, responses, and especially the benefits that humans accrue directly from biodiversity. Particular gaps in knowledge include, amongst others, national level management responses to invasive alien species. Despite these challenges, there are enough data on key dimensions of biodiversity to conclude that at the global scale the 2010 target was not met.

The principal factors that are considered to have contributed to the failure to reach the 2010 target include inadequate policy and lack of implementation of appropriate biodiversity-relevant policy. For example, protected areas do not cover critical biodiversity sites or marine habitats well enough. They are also under-resourced and often inadequately managed. International action and co-ordination of efforts within and across countries and regions has not been good enough, for example, on the management of invasive alien species. Biodiversity, like climate change, needs to be mainstreamed into the policies of multiple sectors. There are also time-lags between policy interventions, conservation actions and biodiversity responses and the benefits of previous investments in biodiversity conservation may not yet be evident. Perhaps most importantly, the economic value of biodiversity has not been adequately considered in decision making, e.g. short-term benefits from habitat conversion have typically been prioritized. Finally, these factors are exacerbated by lack of awareness of the importance and urgency of the biodiversity crisis among decision-makers and the public. The results in Butchart *et al.* (2010) clearly show that despite a few encouraging achievements, efforts to tackle the loss of biodiversity need to be substantially expanded and strengthened. Sustained investment in coherent global biodiversity monitoring and indicators is essential to track and improve the effectiveness with which biodiversity loss is dealt with in future.

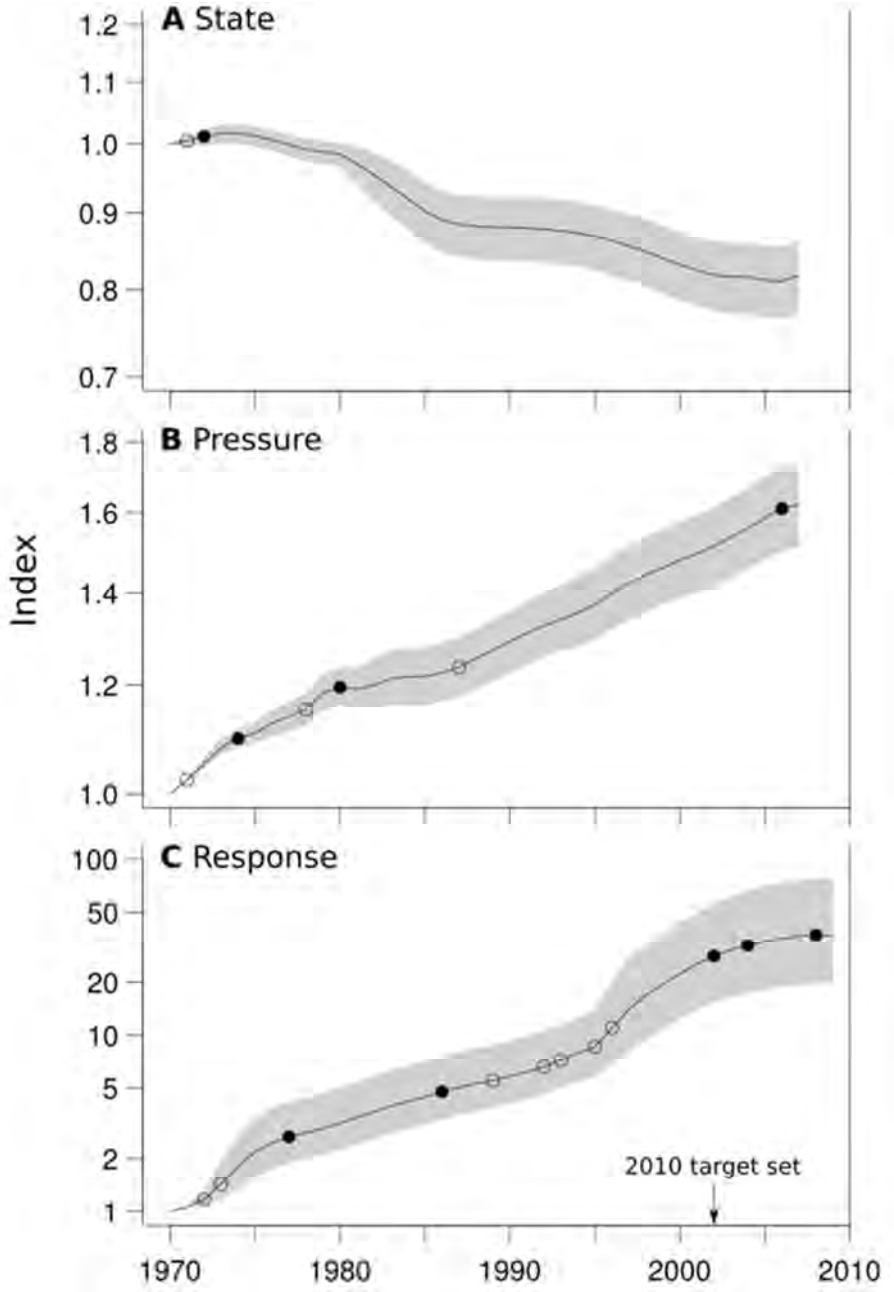


Figure 19. Aggregated indices of (A) the state of global biodiversity based on 9 indicators of species population trends, habitat extent/condition and community composition; (B) pressures on biodiversity based on 5 indicators of Ecological Footprint, nitrogen deposition, numbers of alien species, over-exploitation, and climatic impacts; and (C) responses for biodiversity based on 6 indicators of protected area extent and coverage, policy responses to invasive alien species, sustainable forest management and biodiversity-related aid. Values in 1970 set to 1. Dashed lines show upper and lower 95% confidence intervals derived from 1 000 bootstraps. Significant positive/upward (○) and negative/downward (●) inflections are indicated.

1.3.7 Invasions, science and society

The 'knowing-doing gap' in biological invasions was under the spotlight during 2010. Despite considerable advances in understanding how invasive species work, concern is often expressed regarding how such improved knowledge is put to work to reduce the extent and impact of invasions. Two C·I·B-led studies explored aspects of the knowing-doing gap.

The first study set out to explore the extent to which the invasion biology research is addressing the challenges associated with management and mitigation of the impacts of invasions (Esler *et al.* 2010). Using bibliometric analysis, the extent to which the literature on the subject contributes to implementation of knowledge generated was investigated, by

addressing aspects of management, policy, and/or implementation; the impact of these papers as indicated by the number of citations they attract; and the geopolitical scale of focus of invasion ecology papers, particularly those that attempt to bridge the knowing-doing gap. These findings were then compared with the information needs of conservation practitioners. The authors first examined, globally, popular search engines and then narrowed the focus to South Africa – one of three regions outside USA where researchers producing highly-cited papers in invasion ecology are well represented. At this level, they conducted a content analysis of invasion ecology-related papers, of which at least one author was affiliated to a South African institution. The knowledge base in the field of invasion biology is comprised largely of research oriented towards 'knowing', while research aimed at strategically applying or implementing that knowledge ('doing') is poorly represented in the scientific literature, and the scale of its emphasis is not local. Conservation practitioners clearly indicate a need for basic knowledge. However, invasion science must develop channels for effective engagement to ensure that the research is contextualised, and will deal with the complex ecological, social and economic challenges posed by invasions.

The second study (Shaw *et al.*, 2010) set out to explore the dynamics of interactions between researchers in the field of biological invasions and managers attending two international forums on biological invasions held in 2008 and 2009. The work describes an initiative to improve the flow of information between researchers and managers. Formal workshops and information sessions for land managers were run during the symposia. At the end of each symposium, the managers ran dedicated question-and-answer sessions on the research they felt was needed to improve their work. Such interventions have the potential to increase interaction and awareness between researchers and managers. The symposia provided managers with opportunities to think about broader issues and develop contacts. However, problems with terminology use and the lack of solutions specific to their context tempered the value of their experience. Conversely, researchers at times under-estimated the managers' perceived relevance of their presentations to management. The structured and facilitated attendance of managers of invasive plants at international conferences on invasion biology is one mechanism for at least narrowing ''the knowing-doing gap'' between science and management.

Alien conifers have been widely planted in the Southern Hemisphere. Australia, New Zealand and South Africa, all with long histories of alien conifer planting, have major problems with invasive conifers. Widespread planting of alien conifers has a much shorter history in South America, and invasions are a recent phenomenon. Collaboration between the C·I·B , the University of Tennessee and South American colleagues on the ecology on conifer invasions started with a workshop in Argentina in 2007. The latest project carried out by the Southern Hemisphere Network on Conifer Invasions involved a major analysis of spread and impacts of alien conifers throughout the southern hemisphere and the generation of projections for

South America. Results (Simberloff *et al.* 2010) suggest an explosion of invasions in South America thanks to the huge recent plantings, especially in Chile but also in Argentina and Brazil. This mass of reproductive trees is generating enormous propagule pressure that will accelerate ongoing invasions and trigger new ones at an increasing rate. Regulations to control conifer invasions, including measures to mitigate spread, were belatedly implemented in New Zealand and South Africa, as well as in certain Australian states. Regulations in South America are currently weaker and piecemeal, but insights from the existing research base on conifer invasions elsewhere is useful for fashioning effective regulations in South America.

Understanding why and how species arrive in a new area is crucial for understanding invasion patterns and identifying potential future invaders. Reptiles are becoming increasingly popular as pet species; this trend has been linked to an increase in the number of alien reptiles establishing non-native populations around the world. Although there are relatively few incidences of alien reptiles establishing populations in South Africa, there is concern that the increase in trade of these species in the country could lead to problems in the future. Van Wilgen *et al.* (2010) examined the presence and abundance of alien reptiles in the South African pet trade. Import trends indicate that species from specific families are favoured above others, specifically those from the families Boidae, Chameleonidae, Elapidae, Pythonidae, Testudinidae and Viperidae. Of these, chameleons, boas and turtles are popular pets, while vipers and elapids are more commonly kept for display purposes in zoos and parks (Figure 20). Further import biases exist within families. For example, in the chameleon family, species with larger body sizes are more likely to be imported than smaller ones. These biases are important to consider when identifying traits linked to species 'invasiveness' or the ability to establish. One might observe that larger bodied species are more likely to invade, but this could merely be as a result of larger-bodied species preferentially being introduced. Abundance is an important determinant of the risk of a species becoming established and invasive, and is dramatically increased by propagule pressure (the number of individuals introduced as well as the number of introduction events). Therefore, characterizing trade volume can help to identify potential problem species. This study thus also attempted to explain the abundance of reptile species traded in South Africa in terms of the presence or absence of specific species traits. The authors found that species with certain traits are more popular than others: venomous and expensive species, though a curiosity, are traded in low numbers, whereas species that are easy to breed and handle or large, colourful or patterned are preferred. Species that are popular as well as being suited to local environments are a specific problem and the information gained through this study can be used to inform policy development and direct management efforts. Two of the key steps for management identified in earlier work were to determine which species are presently kept and traded in South Africa and then to assess which of these species has a high likelihood of establishment or poses a threat to biodiversity, ultimately designing tools to evaluate the risk of species not yet here, but desired for import. Now that the alien species present in the country have been identified,

managers are in a position to start evaluating which of those species traded in high numbers pose significant threats to biodiversity and regulate their trade accordingly. Furthermore, it is also possible to predict the probable popularity of species that are not yet here by evaluating their likely abundance based on their physical and trade attributes. This information will form an important component of risk assessment for future imports.

Figure 20: The popularity of reptile species is influenced by their size (top left: a giant Aldabra tortoise at Tygerberg Zoo), presence of patterns (top right: Gaboon viper, Johannesburg Zoo), bright colours (middle right: Kingsnake, National Zoological Gardens) or interesting features (e.g. the dewlap and spines of this iguana at bottom right), and the ease with which the species can be handled and kept (a snake rests in its water-bowl, in a Johannesburg pet store; middle left).

2 Education and training

2.1 Objectives

The education and training of skilled human resources for the South African National System of Innovation forms a central component of the business of the C·I·B. Recognising the urgent requirement for improving the demographic, gender and age profiles of the South African scientific community, and for retaining excellence in the science system, the C·I·B supports students at undergraduate and 4th year level, as well as, Masters and doctoral level, and post-doctoral associates. The main idea is to draw students and young researchers into the Centre's sphere of influence and to encourage them to think about the research done by the Centre as a rewarding career path. At undergraduate level this is done primarily through the Biodiversity Conservation Academy, run in conjunction with Centre of Excellence for Birds as Keys to

Biodiversity. Much of the research undertaken by the Centre takes place via student training at the post-graduate level.

Several external grant awards mean that the C·I·B is in a position to offer additional studentships and post-doctoral fellowships. Mentoring of graduate students by post-doctoral associates is a strong focus of the education and training KPA, as is co-supervision of students across institutions.

2.2 Progress

The C·I·B supported 75 students and post-doctoral associates in 2010. Six honours students, seven Masters students (including the C·I·B's first M.A. graduate) and three Ph.D. students submitted their theses or graduated, including five students who were supported in previous years (see Section 7.3 for details). Ph.D. student Anne Treasure (Stellenbosch University) was awarded the prize for the best poster in her session at the SCAR Open Science Conference in Buenos Aires, Argentina. University of Pretoria M.Sc. student Rolanda Julius was awarded a tick identification course at Onderstepoort by the Mammal Research Institute at University of Pretoria.

In keeping with the mentoring and development approach taken by the Core Team Members of the Centre, many students led research publications in top international outlets, such as *Conservation Biology*, *Diversity and Distributions*, *Evolutionary Ecology*, and the *Journal of Biogeography*.

The C·I·B's Biodiversity Conservation Academy was held in association with the CoE for Birds as Keys to Biodiversity, funded by the Department of Science and Technology. The Academy was held first in January 2006, and has been held annually since 2008 at Potberg Environmental Education Centre in de Hoop Nature Reserve, Western Cape. In 2010 ten students from five higher education institutions and four interns from SANBI participated in the Academy, 11 of whom were from historically disadvantaged backgrounds and nine of whom were women (Figure 21). Thirteen academic and support-staff from the two CoEs and from SANBI (CREW) and CapeNature helped with the management and running of the Academy. The five-day programme immersed students in an intensive series of theoretical, practical and philosophical discussions and field-work sessions, all concerning biodiversity conservation. The main aim of these sessions was to improve student appreciation for the complexity of biodiversity, sharpen their knowledge and grasp of the skills required to assess it, and broaden their knowledge of the theory and practice of conservation in a South African context.

Figure 21. Participants and staff of the 5th Biodiversity Conservation Academy held in January 2010 at de Hoop Nature Reserve, Western Cape.

3 Information brokerage

3.1 Objectives

One of the central roles of the C·I·B is to foster a knowledge economy, and to use the outcomes of its knowledge production to promote a sustainable society to the benefit of all life. In consequence, information brokerage at a wide variety of levels forms a core component of the C·I·B's business. In essence, two ways exist for the knowledge, skills and insights of the C·I·B team to be made widely available. First, direct interactions with the C·I·B core team, staff, post-doctoral associates and students provide a means for those directly associated with the C·I·B, across a broad spectrum of society, to benefit from the C·I·B's knowledge generation. Typically this contact takes place via scientific and public lectures; researchers interfacing with students and the general public; interactions at workshops, public meetings and science expos; through the direct media such as radio talk shows; and, importantly, through its major outreach intervention, the Iimbovane project. The C·I·B also makes special efforts to host international workshops and meetings to ensure that students can interact with some of the world's leading biodiversity scientists without incurring a substantial, and often unaffordable, cost.

3.2 Progress

3.2.1 Scientific communication with peers

During 2010, the C·I·B produced 93 peer-reviewed publications in journals, and 11 book chapters on a range of topics (see Section 8.2 for details). A total of 67 oral and poster presentations were given at national and international conferences (Section 8.7).

An international workshop was convened to discuss the manifold problems caused by the occurrence of a set of Australian *Acacia* species as aliens in many parts of the world, where some are important crops, and some are very important invasive species. These mean challenging conflicts of interest that are growing in complexity. Much work is underway in South Africa and in other parts of the world to improve current understanding the ecology of these species, with the aim being to improve management. The workshop was attended by 62 delegates from 15 countries and comprised three days of talks and discussions, and one day in the field. A set of 21 papers dealing with all facets of the evolution and ecology of Australian acacias, their movement around the world, and the range of responses being considered is in preparation. These will be collected in a special issue of the journal *Diversity and Distributions* (working title: *Human-mediated introductions of Australian Acacia species – a global experiment in biogeography*) which will be published in the second half of 2011.

3.2.2 Scientific communication with students

The primary mechanism for communication with students is the Annual Research Meeting, which was held on 18 and 19 November 2010 at Stellenbosch University. The annual student awards for the best oral and poster presentations went to Jeremy Shelton (Ph.D., UCT) for his oral presentation on *The ecological impact of alien rainbow trout in the Cape Floristic Region, South Africa* and to Michelle Gibson (M.Sc., SU) for her poster titled *How alien invasive plants fit into pollination/seed dispersal networks in different habitats*. Megan Nowell (M.Sc., SU) received special mention for her poster *Determining the net benefits of clearing invasive alien vegetation on the Agulhas Plain.*

3.2.3 Communication with partners

A five-day course on *Biological invasions: recent advances and traditional tools* was held during October 2010 at Howick in KwaZulu-Natal. The course was a joint venture between the C·I·B, as part of its collaborative research project with Working for Water (WfW), and the Early Detection and Rapid Resource (EDRR) Programme of SANBI, and was co-ordinated by David Richardson (C·I·B), John Wilson (C·I·B /SANBI EDRR) and Ingrid Nänni (SANBI EDRR), with inputs from invited consultants and guest lecturers. The course was structured to serve the needs of middle to upper-level regional management personnel in WfW and EDRR throughout South Africa, and set out to present an overview of international best practice in environmental management with a strong emphasis on requirements for managing invasive species. There were four days of lectures, discussion groups and practical demonstrations, and a full-day field trip focussing on mapping and surveying invasive species. The course was attended by ten people from EDRR and six from WfW. Session topics and co-ordinators were as follows: 1) Plant pressing and identification: Theory and practice (Christina Potgieter and Angela Beaumont; SANBI); 2) Biological invasions in a changing world: An introduction to invasion science (David Richardson, C·I·B); 3) Regulation: the good, the bad and the ugly:

some insights from international experience (John Donaldson, SANBI); 4) Jacarandas, leopard toads and earthworms; Managing social conflict through invasive alien species partnerships in South Africa (Kay Montgomery; freelance media consultant); 5) Population modelling (John Wilson; SANBI/C·I·B); 6) An introduction to risk analysis (Joslin Moore, University of Melbourne, Australia); 7) Containment and eradication: insights from case-studies (Michael Braack; Invasive Alien Species Programme, KZN Department of Agriculture, Environmental Affairs and Rural Development); 8) The reproductive biology of invasive plants (Steve Johnson and James Rodger; University of KwaZulu-Natal); 9) Modelling the spread and distribution of invasive species (Mathieu Rouget and Mark Robertson; University of Pretoria); 10) Biological control (Terry Olckers; University of KwaZulu-Natal). The one-day field trip was co-ordinated by Michael Braack (KZN Department of Agriculture, Environmental Affairs and Rural Development) and Ingrid Nänni (SANBI EDRR).

Figure 23.Participants from EDRR and WfW assessing new invasive species as part of the field course held at Howick, KwaZulu-Natal.

3.2.4 Communication with the public

C·I·B homepage

The C·I·B homepage remains an important mechanism for communication with the public, and during 2010 a series of reviews of C·I·B research publications was started. The web pages achieved an average of 1 405 hits per month during 2010, and a total of 16 860 for the year.

Iimbovane Outreach Project

The project has grown over the past five years into a working example of how biodiversity education at the secondary school level can successfully be merged with the long-term monitoring of biodiversity. The project was initiated in 2005 to improve the knowledge and skills of Grade 10 learners and life science educators in their understanding and application of biodiversity science and has since been very successful in doing so. In 2009, a major development for Iimbovane was the expansion of the project to more secondary schools in the Western Cape. Building on this success, the project has seen the successful implementation and participation of the new schools in the project activities in 2010 and is now fully operational in the original 13 schools, the five new schools in the full support system; and in the additional ten schools in the subscription system[1] (see Table 2).

Table 2: List of full support and subscription schools participating in the Iimbovane Outreach Project

School	Town location	EMDC
(a) Full participation schools		
Augsburg Gymnasium	Clanwilliam	West Coast
Cape Academy for Mathematics, Science and Technology	Tokai, Cape Town	Metro South
Diazville Secondary School	Saldanha	West Coast
Emil Weder High School	Genadendal	Overberg
Fezekile Secondary School	Oudtshoorn	Eden/Karoo
Gerrit du Plessis Secondary School	Riversdale	Eden/Central Karoo
Groendal Secondary School	Franschoek	Cape Winelands
Ikamvalethu Finishing School	Langa	Metro Central
Luhlaza High School	Kayalitsha	Metro East
Manzamthombo High School	Blackheath	Metro North
Riviersonderend High School	Riviersonderend	Overberg
Sentraal High School	Beaufort West	South Cape/Karoo
South Peninsula High School	Dieprivier, Cape Town	Metro South
Swartberg Secondary School	Caledon	Overberg
Swellendam Secondary School	Swellendam	Overberg
Umyezu Wama Apile Secondary School	Grabouw	Overberg
Vusisizwe Secondary School	Worcester	Cape Winelands
Weltevrede Secondary School	Wellington	Cape Winelands
(b) Sugar Ant (subscription) schools		
Albert Myburgh Secondary School	Bredasdorp	Overberg
Atlantis Secondary School	Atlantis, Cape Town	Metro North
Breërivier Secondary School	Worcester	Cape Winelands
Lavender Hill Secondary School	Retreat, Cape Town	Metro South
Luckhoff Secondary School	Stellenbosch	Cape Winelands
Malibu Secondary School	Blue Downs	Metro East
Ravensmead High School	Ravensmead, Cape Town	Metro North
Sarepta Secondary School	Kuilsrivier	Metro East
Sibelius Secondary School	Retreat, Cape Town	Metro South
Vredendal Secondary School	Vredendal	West Coast

[1] 'Full support schools' include the core 18 schools of the project and receive assistance from the Iimbovane project team during fieldwork activities; 'subscription schools' participate in a streamlined version of the project, and perform the fieldwork activities without the assistance of Iimbovane project team.

The year 2010 started with an in-depth training workshop for educators from the new schools as well as new educators from the original schools. The workshop was held at Stellenbosch University in January 2010 and presented the educators with basic training on the implementation of the project in their schools, from the theoretical concepts of biodiversity through to performing the associated fieldwork. In addition, the workshop empowered the participating educators through the provision of practical sessions in the use of microscopes in their school laboratories. To conclude the workshop, educators received a certificate on behalf of their schools' participation. Educators were also provided with the Iimbovane starter pack and educational materials that were discussed during the workshop sessions.

Between March and October 2010, the project team visited the 18 full-support schools on three occasions. Outreach visits to schools in March 2010 presented learners with lessons on biodiversity and the scientific method before they performed their own scientific investigations at research sites on their school grounds. Learners from all the full-support schools participated in this event and three of the schools were able to accompany the project team to a nearby nature reserve to collect data at their control site. In July the project team continued with their third outreach visit to the participating schools. This outreach visit comprised of the annual data handover, during which the project team presented the learners with the data they collected. By using their own data, learners were able to make the link between the formulation of a research question, performing the investigation and interpreting the results. The lessons were well received and as expected, data interpretation and calculation abilities varied between learners and schools. This visit also provided the opportunity to hand over the donated educational equipment to the five new full-support schools. Learners were enthusiastic about the high quality microscopes handed over to their schools.

The June school holidays provided the ideal time to host the inaugural Iimbovane Biodiversity Winter Week for learners from the ten subscription schools. Promising learners from each subscription school were identified and invited to spend a week at the Iimbovane ant laboratory on the campus of the Stellenbosch University. During the event the learners were informed about South African biodiversity and biodiversity science as a field of study. This was done through lectures, interactive activities and field excursions. The winter week was very important to the project as it served as a measure of success of the newly implemented subscription system. Following the educator training workshop in January 2010, subscription schools were expected to implement the project without the assistance of the project team. Learners from the schools could then use the winter week programme to identify their ant samples with the assistance of the project team. The winter week was attended by 18 learners from seven of the ten subscription schools. These schools successfully implemented the project and were able to present ant samples at the winter week.

During 2010 the Iimbovane Outreach Project interacted with approximately 1850 Grade 10 learners from secondary schools across the Western Cape. In total 17 of the participating schools are located in rural areas and 11 in urban areas. Of the 28 schools that benefitted from the project, 93% (26 out of 28 schools) were beneficiaries from the black group as defined by the BBBEE codes of good practice. From the 31 life science educators that were trained through the project in 2010, 65% were women of which 70% (14 out of 20) were from the black group as defined by the BBBEE codes of good practice.

Figure 24. Learners from Diazville Secondary School performing vegetation surveys as part of the Iimbovane Outreach Project

The project remained significant in raising awareness about local biodiversity issues within the wider education community and communication about the project took place at a number of events. Ms. Du Plessis was invited to present a talk, which used Iimbovane as a working example of a citizen science project with school learners, during an academic delegation visit to the Humboldt University, Berlin. Ms. Jumbam was invited to deliver a plenary talk about the success of Iimbovane at the 2nd Annual Working for Water National Teachers Conference in Polokwane. This presentation was especially well received by educators that attended the conference. On a more local platform Ms. Du Plessis was invited to present the project at a seminar series of the South African National Biodiversity Institute, Kirstenbosch.

The Iimbovane Outreach Project was involved in several outreach events during 2010. In March the project hosted an exhibition at the annual Kirstenbosch Biodiversity Expo. At this

event two learners from the 2009 Iimbovane group at the Manzomthombo Secondary School represented the project. As part of the Standard Bank 2010 Mathematics and Science Week the project facilitated a workshop, *Backyard Biodiversity* for participating Grade 10 learners. In conjunction with the Cape Town Science Centre, the project team played a part in the National Science Week that was held in August 2010. At this event members of the project team used the opportunity to tell learners about the different study opportunities in biological sciences. Two learners from the Vredendal Secondary School also made the Iimbovane project their own by using it as a guide for their project preparations for the Eskom Expo for Young Scientists 2010 in Stellenbosch.

For the period under review, the project's activities continued to generate interest from the media. The January 2010 educator's workshop was well received with an article in a local newspaper, *The Franschoek Tatler*. The project also featured in the local newspaper, *Weslander*, following the handover of donated microscopes to the Diazville Secondary School in Saldanha. The project also featured in various popular magazines, for example, in *Go Wild* and *Quest.* In terms of radio broadcasting, Ms. Du Plessis was interviewed by Wandile Kallipa, on the international channel, *Channel Africa* concerning the Iimbovane Outreach Project. In addition to traditional media platforms, the project also joined social media with profiles on *Facebook* and *Twitter.* This allowed the project to be in contact with participating learners and might prove to become a valuable tool to monitor the impact of the project. One way of ensuring the project's impact among its beneficiaries is to monitor whether learners took the project further than their participation in the classroom. The following case studies reflect the project's impact.

Nathi Ngwane and Only Mookoa from Manzomthombo Secondary School participated in the Iimbovane Outreach Project in 2009. This was however not the end for these two learners as they were interested in learning more about biodiversity science as a career. With much enthusiasm and interest the learners enquired whether they could assist the project the following year. In March 2010, Nathi and Only represented the Iimbovane Outreach Project at the annual 4-day Kirstenbosch Biodiversity Expo. The learners were at home behind the Iimbovane exhibition and proudly informed visitors about their role in the project. Following their participation in the expo, the learners were interested in finding out what happens in the Iimbovane ant identification laboratory and the two learners were allowed to work in the laboratory during their school holiday.

For Ms. Ursula Carstens, life science educator at Diazville Secondary School, the project provided the necessary means to grow as life science educator and to have access to biodiversity literature. Ms. Carstens was selected as one of the Western Cape teacher representatives at the Working for Water Programme's National Teacher Conference 2010, where she was invited to speak about South African biodiversity. Ms. Carstens was able to use the educational material and resources supplied by the project, to prepare her presentation. Ms. Carstens expressed her gratitude to the Iimbovane Outreach Project with a letter of appreciation to the project team.

Media highlights

During 2010 C·I·B researchers generated a great deal of media interest with items covering themes including Antarctic science, biodiversity, changing environments and invasive species.

Antarctic Science

The C·I·B's involvement in Antarctic research and the dissemination of information was demonstrated through numerous media interactions. In June 2010 Steven Chown received the Martha T. Muse Prize in recognition of his outstanding work in science and policy in Antarctica and environs. His receipt of the prize at the fourth International Polar Year Conference in Oslo, Norway, led to several media items including newspaper articles in international media (including many internet sites) as well as in local media such as *Business Day* and *Die Burger*. To further public understanding of the Antarctic regions, Steven Chown and C·I·B Research Associates Aleks Terauds and John Cooper published a popular book titled, *Marion and Prince Edward – Africa's Southern Islands* together with Peter Ryan from the CoE in Birds as Key to Biodiversity at the Fitzpatrick Institute. The book was launched in November 2010 and was reviewed in regional newspapers and in publications of the Stellenbosch University.

The SANAP Antarctic Legacy Project is an on-going history research project that collects records of the personal experiences and memories of individuals that worked in the Antarctic region. The media announcement of the project in 2010 reached a wide audience with articles published in several popular publications including *Go!*, *Engineering News*, *SA Shipping News*, *Saturday Argus*, *Die Burger* and several community newspapers. Online media coverage was extensive and the news item appeared on websites of *The Green Times*, *Popular Mechanics*, *Republikein*, and *Eco-photo Explorers*. Following the launch of the project, project manager Ms. Dora Scott, was interviewed on Radio Sonder Grense and SAFM. Information about the project, supported independently by the DST and NRF, through the South African National Antarctic Programme, can be found at: http://academic.sun.ac.za/cib/antarcticlegacy/

Biodiversity

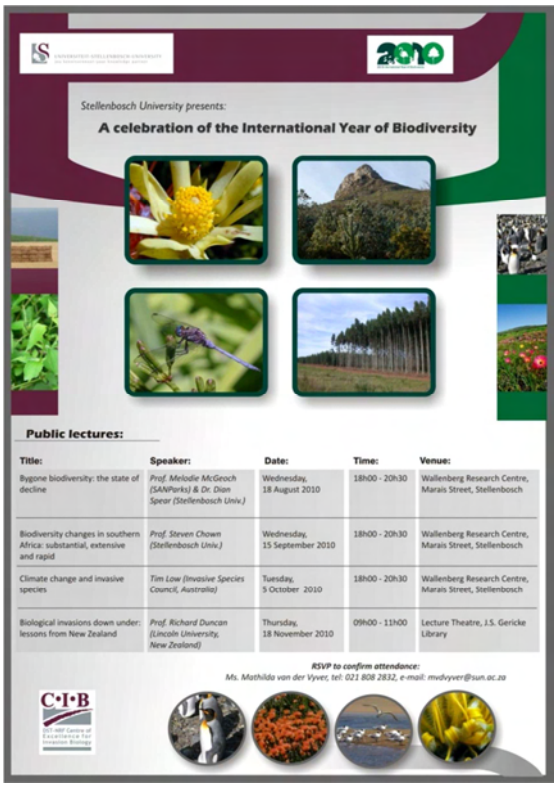
Invasive alien species are a major threat to global biodiversity and the ecosystem services upon which humanity relies. In 2010 the C·I·B continued to improve society's understanding of how invasive alien species contribute to biodiversity loss. A team of researchers headed by C·I·B researcher, Prof. Melodie McGeoch was contracted by the Global Invasive Species Programme (GISP) to develop and populate indicators of biological invasion to measure progress of countries towards achieving the global 2010 Biodiversity Target. (Through the 2010 Biodiversity Indicators Partnership (http://www.twentyten.net), the Global Invasive

Species Programme was tasked with facilitating the development of the indicator of biological invasion). This indicator of biological invasion is one of 22 suggested indicators used to measure achievement of the 2010 Biodiversity Target, to achieve by 2010 a significant reduction in the current rate of biodiversity loss at the global, regional and national level. The development of the Global Invasive Alien Species Indicator (http://academic.sun.ac.za/iasi/) led to the publication *Global indicators of biological invasion: species numbers, biodiversity impact and policy responses* in the journal *Diversity and Distributions*. The publication caused for a great deal of attention in the international press with articles on leading international news sites including *BBC News Today*, *International Union for Conservation of Nature (IUCN)*, *National Geographic*, *The Guardian* (UK) and *Birdlife International*. The outcomes of the paper were further disseminated through an interview on BBC News Today with co-author of the study and global research director at Birdlife International, Dr. Stuart Butchart. (Access the interview: http://news.bbc.co.uk/today/hi/today/newsid_8474000/8474213.stm)

Following the development of the indicators of biological invasion, the research team also contributed to an assessment (using 30 indicators of biodiversity change) of the global effort to achieve the 2010 Biodiversity target. This outcomes of this assessment showed that the rate of biodiversity loss has not been significantly reduced and the results of this study were published in *Science* magazine. The paper in *Science* titled *Global Biodiversity: Indicators of Recent Declines* caused great excitement in the international media scene with numerous articles on some of the foremost international news sites. Articles appeared on the websites of *Nature*, *Daily Mail*, *World Science*, *Science Now*, *BBC News*, *The Telegraph*, *Time* and several European news sites. Articles about this paper also appeared in national publications including *Fishing Industry News Southern Africa*, *Borehole Water Journal*, *Landbouweekblad*, *Bolander*, *Sunday Argus*, *Die Burger* and *Business Day*. Prof. Melodie McGeoch was interviewed for *567 Cape Talk Radio*, *Radio Sonder Grense*, *OFM* and *FMR 101.3*.

Prof. Steven Chown was further recognised for his contribution to biodiversity research when he was invited to deliver a paper at the Royal Society 350th anniversary in London, October 2010. In his lecture, *Temporal changes in transformed landscapes: a southern systems perspective*, Prof. Chown provided current evidence of the extensive and rapid changes in terrestrial biodiversity in southern Africa. The paper which was published in the peer-reviewed journal, *Philosophical Transactions of the Royal Society*, highlights specific studies that emphasize biodiversity change due to five recognized global environmental change drivers: habitat alteration, exploitation, climate change, biological invasions and pollution. Media mentions in national media include online articles in *Times Live*, The *Green Times* and *Business Day*.
(Listen to the lecture:http://downloads.royalsociety.org/audio/DM/DM2010_04/Chown.mp3).

The year 2010 was earmarked as the International Year of Biodiversity and to celebrate the initiative the C·I·B hosted a series of four public lectures in collaboration with the Department of Botany and Zoology, and on behalf of Stellenbosch University. The series was introduced by Prof. Melodie McGeoch and C·I·B researcher Dr. Dian Spear with a lecture that reflected on whether recent conservation efforts, including the Convention on Biological Diversity, have been successful in its efforts to halt biodiversity loss. The series also included lectures from distinguished Australian writer and author of *Feral Future – the untold story of Australia's exotic invaders*, Tim Low, and C·I·B Director, Steven Chown. The public lecture series concluded with a talk by Prof. Richard Duncan, an expert in biosecurity from Lincoln University in New Zealand. Lectures were well attended by media representatives and resulted in a number of media articles that conveyed the essence of the presentations.



Changing environments

Environmental change and in particular climate change has had, and will continue to have, substantial effects on human society. One such C·I·B project is investigating the effect global climate change on the distribution of insects that act as vectors for malaria and human sleeping sickness. Dr. John Terblanche, C·I·B Research Associate and principle investigator on the project, was interviewed in articles in *Volkblad* and *Die Burger (Ooskaap)*. C·I·B researcher, Dr. Susanna Clusella-Trullas received the Antarctic Science 2010 Award to study how marine invertebrates on Marion Island in the sub-Antarctic respond to changing temperature regimes. The study that will enable researchers to make better informed predictions of the effects if global climate change on the geographic distributions of marine invertebrates were covered by articles in the local newspaper, *Bolander* and on some online news websites.

Invasive species

Human activity is associated with a wide variety of risks and one of these risks is the introduction of alien species which subsequently become invasive. The C·I·B proved once more to be one of the leaders in the field of invasive alien plants after hosting a workshop for *Acacia* specialists from around the world. The workshop focused on the ecology and management of Australian acacia as they occur outside their natural environment and become

invasive in South Africa. The workshop received media attention and appeared on the international website of the Global Invasive Species Programme and on national websites including *Cape Action for People and the Environment* (C.A.P.E.) and *The Green Times*.

Dr. Brian van Wilgen was recognised for his valuable research contributions at the annual NSTF Award ceremony where he received the award for his lifetime of work on the impacts of invasive alien plants on ecosystem services. In addition, Brian was also honoured in the South African National Parks' prestigious Kudu Awards 2010 for his research on the management of fire-prone ecosystems, and the ecology and management of invasive alien plants. The achievements by Dr. Brian van Wilgen were reported on in *Cape Argus*, *Business Day* and *Beeld*. Dr. Llewellyn Foxcroft was one of ten recipients of the 2010 Man and Biosphere Programme Young Scientist Awards, which are endorsed by UNESCO. The award will allow him to determine the dispersal patterns of invasive alien plants along the Sabie River catchment, from which suggestions for management may be made. C·I·B associate, Leonie Joubert's receipt of Honorary Mention at the *Sunday Times Literary Awards* for her popular science book, *Invaded: the Biological Invasion of South Africa* was well received by the media and appeared in popular science magazines including *Landbouweekblad*.

The complete list of media interactions can be viewed in the media section (Sections 8.8 and 8.10).

3.2.5 Knowledge Management System

The information content of the Centre's Information Retrieval and Submission System (IRSS) continued to grow in 2010. By the end of the year the IRSS contained 703 items, veering the Centre's long term projects (78 items), publications (512), datasets and theses (61) and post-doc and student outputs (52).

4 Networking

4.1 Objectives

Scientific progress is realized in a variety of ways, from key breakthroughs by individuals to solutions generated through large, multidisciplinary collaborations. The C·I·B encourages a variety of approaches to scientific excellence, and facilitates networking both among its members and with like-minded individuals and organizations in South Africa and abroad. In consequence, networking continues to be a critical component of the C·I·B's work.

4.2 Progress

4.2.1 Agreements with partner institutions

Active collaboration was maintained with partner institutions. The relationship with key partner SANBI resulted in the C·I·B being contracted to produce the invasive alien organisms

section of South Africa's Second Communication to the UNFCCC. In November 2010 the draft chapter was approved by Cabinet and will be released for public comment.

Two new core team members were appointed by the C·I·B Board in 2010. Dr. Llewellyn Foxcroft (Scientist: Invasion Ecology, Savanna Ecology Research Unit, SANParks) and Dr. Olaf Weyl, Senior Aquatic Biologist at the South African Institute for Aquatic Biodiversity (SAIAB). Dr. Weyl's research focus is on fish conservation and alien fish invasions. The research is multidisciplinary and focuses not only on describing natural systems and processes but also on understanding how humans alter and benefit from aquatic systems. A Research Associate agreement was concluded with Prof. Armanda Bastos, Department of Zoology and Entomology, University of Pretoria.

4.2.2 New international agreements

None

4.2.3 New national agreements

An agreement to facilitate the Centre's participation in the International Barcode of Life (IBOL) was concluded with the South African Institute for Aquatic Biodiversity (SAIAB) in 2010. The joint project with SAIAB will provide support for a post-doctoral associate working in the Centre over three years (2011-2013).

4.2.4 Academic visitors to C·I·B core team members

Dr. Ara Monadjem, Department of Biological Sciences, University of Swaziland, Manzini. *Rodent biology/ecology* (Chimimba).

Professor Robert Miller, Medical Research Council, University of Edinburgh, UK. *Mammalian reproduction* (Chimimba).

Prof. H.P. Leinaas, University of Oslo, Norway, *Soil diversity* (Chown).

Prof. J. Bengtsson, Swedish Agricultural University, *Soil diversity* (Chown).

Prof. P. Convey, British Antarctic Survey, *Antarctic invertebrate phylogeography* (Chown).

Prof. L. Peck, British Antarctic Survey, *Antarctic marine physiology* (Chown).

Ms. Kate Mitchell, University of Melbourne, *Insect thermal tolerance* (Chown).

Prof. L. Deharveng, National Museum of Natural History, Paris, *Springtail systematics* (Chown).

Dr. Anne Bedos, National Museum of Natural History, Paris, *Springtail systematics* (Chown).

Prof. Richard Duncan, Lincoln University, Christchurch, *Invasion ecology* (Chown).

Dr. Anna Jacobsen, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield. *Post-fire recovery in Fynbos, specifically on demography and ecophysiology of resprouting species* (Esler).

Dr. Brandon Pratt, Department of Biology, California State University Bakersfield. *Post-fire recovery in Fynbos, specifically on demography and ecophysiology of resprouting species* (Esler).

Dr. C. Swift, Department of Biology, Whittier College, Whittier, CA 90608 USA, *Water relations in Riparian trees* (Esler).

Prof. Mark van Kleunen, Institute of Plant Sciences, University of Bern, Altenbergrain 21, CH-3013 Bern, Switzerland. *Global associations between plant breeding systems and ecology* (Johnson).

Prof. Klaus Riede, Koenig Museum, Germany. *Acoustic profiling of the landscape* (Samways).

Prof. Erik Svensson, Lund University, Dept Ecology. *Thermal imaging of landscape* (Samways).

Prof. Bill Roebuck, Dartmouth College, USA. *Dung beetle research in Tembe Elephant Park* (van Rensburg).

Dr. Kate Parr, Research fellow in African ecology, Centre for the Environment, Oxford University, UK. *Relationships between patterns in invertebrate (ants and termites) diversity and environmental gradients (altitude and fire frequencies)* (van Rensburg).

Dr. Jesse Kalwij, Senior Research Fellow, Institute of Ecology and Earth Science, Estonia. *Spread of alien invasive plants along altitudinal gradients* (van Rensburg).

Prof. L Nagelkerke, Wageningen University, Aquaculture and Fisheries Group, Wageningen, The Netherlands. *Impacts of invasive fishes in the Amathole Mountain region* (Weyl).

Dr. Jos Moore, Australian Research Centre for Urban Ecology School of Botany University of Melbourne, Australia. *Decision support models for managing biological invasions* (Wilson).

Profs Ben Oldroyd and Madeleine Beekman, School of Biological Sciences, University of Sydney, Australia. *Reproductive dynamics within the hybrid zone and social parasitism in the Cape honeybee* (Wossler).

4.2.5 Academic visits by core team members to other institutions

Department of Biology, University of Malawi (Zomba, WN Chitaukali, HOD) and Department of National Parks and Wildlife (Lilongwe, G. Jiya and A. Lipiya, Directors). *Small mammal research with special focus on invasive species* (Chimimba).

British Antarctic Survey, Cambridge, U.K. *Antarctic invertebrate phylogeography and ecology with Prof. P. Convey* (Chown).

University of Oslo, Norway including two weeks on Svalbard, *Springtail life history variation with Prof. Hans Petter Leinaas* (Chown).

Dept. of Animal Physiology, Systems Neurobiology and Neural Computation. Humboldt-University, Berlin. *Dr. Stefan Hetz's Insect Physiology Laboratory* (Clusella-Trullas).

Department of Ecology, Charles University, Prague, Czech Republic, and Institute of Botany, Academy of Sciences of the Czech Republic *Determinants of spread and effect of boundaries as filters to invasion, with Prof. Vojtěch Jarošík and Prof. Petr Pyšek* (Foxcroft).

Biodiversity and Landscape Ecology Lab, Centre Tecnològic Forestal de Catalunya, Spain. *Dynamic species distribution models with Prof. Lluis Brotons* (Hui).

Institute of Plant Sciences, University of Bern, Switzerland. *A unified framework for invasion biology* (Richardson).

University of La Plata, Argentina. *Freshwater assessments with Prof. J Muzon* (Samways).

Frankfurt Zoological Society - Bale Mountains Conservation Project, Ethiopia. *Collaboration on land transformation impacts on biodiversity with Dr. Anouska Kinahan*. (van Rensburg).

Origine, Structure et Evolution de la Biodiversité, Museum National d'Histoire Naturelle, France. *Documenting faunal soil biodiversity in the Cape Floristic Region* (van Vuuren).

4.2.6 Travel awards to Core Team Members

Stellenbosch University, Vice-Rector's Discretionary Fund (ZAR 10 000); partial support for travel to the Society for Experimental Biology Annual Main Meeting, Prague 30th June to 3rd of July 2010 (Clusella-Trullas).

Mobility Grant for visiting Professors; travel to Charles University, Prague, Czech Republic (Foxcroft).

France/SA Scientific Cooperation Agreement; travel to Natural History Museum in Paris, France for project *Uncovering springtail diversity in the South African Cape Floristic Region: a combined taxonomic and barcoding approach* (van Vuuren).

NRF ISL Travel Award to attend the SCAR Business meetings (July 30-August 2, 2010) in Buenos Aires, Argentina, as part of the South African Delegation (van Vuuren).

4.2.7 Research collaborations

Research on *Rattus* in South Africa. Collaborators: Dr. Armanda Bastos, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa; Dr. Frikkie Kirsten and Dr. Emil von Maltitz, Plant Protection Research Institute (PPRI), Agriculture Research Council, Pretoria, South Africa (Chimimba).

Acclimation effects in stochastic environments. Collaborator: Dr. Jesper Sørensen, Aarhus Centre for Environmental Stress Research, Ecology and Genetics, Department of Biological Sciences, University of Aarhus (Chown).

Discontinuous gas exchange in insects. Collaborator: Dr. Craig White, School of Integrative Biology, University of Queensland (Chown).

Environmental physiology of insects and other groups. Collaborator: Dr. John. S. Terblanche, Department of Conservation Ecology and Entomology, Stellenbosch University (Chown).

Albatrosses as ecosystem engineers. Collaborator: Dr. Brent J. Sinclair, Department of Biology, University of Western Ontario, London, Ontario, Canada (Chown).

Macroecology and macrophysiology for a changing world. Collaborator: Prof. Kevin J. Gaston, BIOME Group, Department of Animal and Plant Sciences, University of Sheffield (Chown).

Soil biodiversity in the Fynbos: patterns and processes. Collaborator: Prof. Janne Bengtsson, Department of Ecology, Swedish Agricultural University (Chown).

Soil faunal responses to changing, variable environments: a bi-polar approach linking individuals to ecosystems. Collaborator: Prof. Hans-Petter Leinaas, Department of Biology, University of Oslo, Norway (Chown).

Impacts of cats and rabbits on Macquarie Island. Collaborator: Dr. Dana M. Bergstrom, Australian Antarctic Division, Hobart, Tasmania, Australia (Chown).

Soil invertebrates on Heard and Macquarie Islands. Collaborator: Dr. Dana M. Bergstrom, Australian Antarctic Division, Hobart, Tasmania, Australia and Dr. Aleks Terauds, Azorella Consulting, Australia and C·I·B Research Associate (Chown).

Aliens in Antarctica. International Polar Year Programme. Collaborator: Consortium with Dr. A.H.L. Huiskes, NIOO, Netherlands and Dr. Dana M. Bergstrom, Australian Antarctic Division, Hobart, Tasmania, Australia (Chown).

Physiology of *Ceratitis* fruit fly invasive potential. Collaborator: Dr. John Terblanche, Department of Conservation Ecology and Entomology, Stellenbosch University (Weldon and Chown).

Geographic variation in water loss and recovery of a widespread velvet worm. Collaborator: A/Prof. Savel Daniels, Department of Botany and Zoology, Stellenbosch University (Weldon, Clusella-Trullas and Chown).

Assessing the taxonomy, systematics and evolutionary history of Antarctic tardigrades. Collaborator: Mr Chester Sands, British Antarctic Survey, Cambridge, UK (Lee and Chown).

Determination of the diversity of bacteria and Archaea in Antarctic soil. Collaborator: Prof. Esta van Heerden, Metagenomics Platform, Department of Biotechnology, University of the Free State, South Africa (Lee).

Macrophysiology of marine invertebrates. Collaborators: Prof. S.L. Chown, C·I·B, and L. Peck, British Antarctic Survey, Cambridge, UK (Clusella-Trullas).

Plasticity of active metabolism and speed of locomotion in insects. Collaborators: Dr. John S. Terblanche, Department of Entomology and Conservation, and Prof. S.L. Chown, C·I·B, Stellenbosch University (Clusella-Trullas).

Mechanisms structuring species assemblages in changing landscapes: dung beetles as model organisms. Collaborator: Prof. Berndt van Rensburg, Department of Zoology and Entomology, University of Pretoria (Clusella-Trullas).

Restoration of natural capital. Collaborators: Prof. James Blignaut. ASSET, Jabenzi, Beatus and Department of Economics, University of Pretoria, Prof. Sue Milton. RENU KAROO, Prince Albert and Dr. David Le Maitre. CSIR Natural Resources and Environment, PO Box 320, Stellenbosch 7599 (Esler).

Restoration of natural capital and sustainable harvesting of natural products. Collaborator: Flower Valley (Mr Sean Privett, Dr. Mirijam Gaertner) (Esler).

Landowner attitudes. Collaborators: Dr. Heidi Prozesky (C·I·B), Dr. Guy Preston (WfW) and Ms. Lauren Urgenson (Washington State University) (Prozesky, Esler).

Restoration and monitoring. Collaborator: Dr. Belinda Reyers, CSIR Natural Resources and Environment, PO Box 320, Stellenbosch 7599 (Esler).

Post-fire regeneration in Fynbos. Collaborator: Dr. Brandon Pratt, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311-1099 (Esler).

Drought response in Fynbos. Collaborator: Dr. Anna Jacobsen, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311-1099 (Esler).

Water relations in riparian vegetation. Collaborator: Dr. Cheryl Swift, Department of Biology, Whittier College, Whittier, CA 90608 USA (Esler).

Fragmentation effects in Fynbos Proteaceae. Collaborator: Dr. Frank Shurr. Plant Ecology and Nature Conservation, University of Potsdam, Maulbeerallee 3, 14469 Potsdam, Germany (Esler).

Determinants of spread and effects of boundaries as filters to invasion. Collaborators: Prof. Vojtěch Jarošík and Prof. Petr Pyšek, Department of Ecology, Charles University, Prague, Czech Republic, and Institute of Botany, Academy of Sciences of the Czech Republic. Prof. David Richardson, DST-NRF Centre for Invasion Biology, Stellenbosch University (Foxcroft).

Parasite communities on alien freshwater fish species and their potential spread to, and impacts on, indigenous fish. Collaborator: Dr. Kevin Christison, Marine and Coastal Management (Griffiths).

Impacts of introduced freshwater fishes on threatened fish species in the Cape Floristic Region. Collaborators Prof. Paul Skelton, SAIAB, Grahamstown; Prof. Jenny Day. Freshwater Research Unit, UCT; Dr. Dean Impson, Cape Nature (Griffiths).

Compilation of list of introduced marine species in South Africa. Collaborator: Prof. James Carlton, Professor of Marine Sciences, Williams College, Williamstown, Massachusetts (Griffiths).

Phylogenetics of the ascidian genus *Pyura*. Collaborator: Dr. Peter Teske, Macquarie University, Australia (Rius).

Genetic patterns of ascidian introductions along the coast of South Africa. Collaborator: Dr. Sophie von der Heyden, Stellenbosch University (Rius).

Guide book to introduced animals in South Africa. Collaborators: Profs Gary Bronner, Mike Picker and Phil Hockey, UCT Zoology Department; Dr. Graham Alexander, Wits University; Drs Dai Herbert and Danuta Plisco, Natal Museum; Dr. Olaf Weyl, SAIAB; Prof. Chris Appleton UKZN; Drs Ian Miller, Michael Stiller, Riaan Stalls, Ansie Dippenaar, Eddie Ueckermann, Agricultural Research Council; Dr. Ashley Kirk-Spriggs, National Museum, Bloemfontein; Dr. Kevin Christison, MCM:DEA (Griffiths).

Molecular ecology of tropical tree invasions in the Pacific. Collaborator: Dr. Denise Hardesty, The Commonwealth Scientific and Industrial Research Organisation (Le Roux).

Invasive alien species and protected areas. Collaborators: Dr. Llewellyn Foxcroft (SANParks), Dr. Dian Spear (C·I·B), Dr. Nicola van Wilgen (SANParks) (McGeoch).

A multi-stakeholder assessment of incentives and barriers to invasive plant management in the Western Cape). Collaborators: Prof. Karen Elser (C·I·B), Dr. Guy Preston (WfW) and Ms. Lauren Urgenson (Washington State University) (Prozesky, Esler).

Bibliometrics as a tool for measuring gender-specific research performance: An example from South African invasion ecology. Collaborator: Mr N. Boshoff (Centre for Research on Evaluation, Science and Research, SU) (Prozesky).

Cytosystematics of Madagascan bats: Collaborators: Prof. PJ Taylor, School of Environmental Sciences,University of Venda; JM Lamb, School of Biological and Conservation Sciences, University of KwaZulu Natal; CM Schoeman, School of Biological and Conservation Sciences, University of KwaZulu Natal; Prof. Steven Goodman, Field Museum of Natural History, Department of Zoology, Chicago), and Dr. Fengtang Yang, The Wellcome Trust Sanger Institute, Wellcome Trust Genome Campus, Cambridge, UK and Ms. Leigh Richards(Curator of Mammals at the Durban Natural Science Museum) (Rambau).

Phylogeography of gerbils: Dr. Teresa Kearney, Department of Mammalogy, Transvaal Museum, Pretoria (Rambau).

Cytosystematics of gerbils: Drs Gauthier Dobigny and Laurent Granjon, Institut de Recherche pour le Développement, Centre de Biologie et de Gestion des Populations, Montpellier, Campus International de Baillarguet, Montferrier-sur-Lez, France (Rambau).

Human usage and land use history and the distribution and status of alien plant species along the Eerste River. Collaborator: Clifton Meek, M.Sc. student, University of Cape Town (Richardson)

Compendium of essential concepts and terminology in invasion ecology. Collaborator: Prof. P. Pysek, Institute of Botany, Academy of Sciences of the Czech Republic (Richardson).

Ecology of conifer invasions in the southern hemisphere. Collaborator: Prof. D. Simberloff, Department of Ecology and Evolution, University of Tennessee, USA (Richardson).

Ecology of eucalypt invasions. Collaborator: Prof. M. Rejmanek, Department of Ecology and Evolution, University of California Davis, (Richardson).

Economic consequences of environmental impacts of alien plant invasions in South Africa. Collaborator: Dr. D.C. Le Maitre, CSIR Natural Resources and Environment, Stellenbosch (Richardson).

Journal special issue on conservation biogeography. Collaborator: Prof. R.J. Whittaker, School of Geography and the Environment, Oxford University (Richardson).

Invasion ecology and restoration ecology: parallel evolution in two fields of endeavour. Collaborator: Prof. R.J. Hobbs, School of Plant Biology, University of Western Australia (Richardson).

Mapping of ecosystem services. Collaborator: Prof. M. Rouget, Department of Plant Science, University of Pretoria (Richardson).

Mutualisms – role as driver of plant invasions. Collaborator: Prof. A. Traveset, Institut Mediterrani d'Estudis Avançats, Mallorca Illes Balears, Spain (Richardson).

Predicting invasiveness of Australian *Acacia* species on the basis of their native climatic affinities, life-history traits and human use. Collaborator: Prof. P. Castro-Diez, Facultad de Ciencias Universidad de Alcalá Ctra, Alcalá de Henares, Spain (Richardson).

Rationalization of questions in the Australian Weed Risk Assessment for use in multiple regions. Collaborator: Dr. D.R. Gordon, The Nature Conservancy, Florida, USA (Richardson).

Quantification of the pathways for reptile introductions in South Africa. Collaborators: Drs J. Elith and B. Wintle, School of Botany; The University of Melbourne; Parkville Victoria 3010, Australia (Richardson).

Chromolaena odorata and biodiversity in Hluhluwe-iMfolozi Park, 2010. Collaborators, Kate Parr, Oxford University, William Bond, University of Cape Town (Somers).

Carnivore Reintroduction Biology and effects on biodiversity, 2004-2010. Collaborators: Micaela Szykman, Humboldt State University; Dave Wildt and Steve Monfort, Smithsonian Institute; Ant Maddock, Joint Nature Conservation Committee (UK); Elisa Cameron, University of Pretoria, Harriet Davies, Endangered Wildlife Trust; Rob Slotow, University of KwaZulu-Natal; Matt Hayward, Australian Wildlife Conservancy, Fred Dalerum, Elisa Cameron, University of Pretoria (Somers).

Biodiversity value and conservation importance of ecological transition zones. Collaborator: Dr. Salit Kark, The Biodiversity Research Group, Dept. of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem (van Rensburg).

Long term change in invertebrate assemblage patterns along an altitudinal gradient in the Sani Pass, Drakensberg. Collaborator: Dr. Kate Parr, Research fellow in African ecology, Centre for the Environment, Oxford University (van Rensburg).

Long term change in alien plant composition along an altitudinal gradient in the Sani Pass, Drakensberg. Collaborator: Dr. Jesse Kalwij, Senior Research Fellow, Institute of Ecology and Earth Science, Estonia (van Rensburg).

Documenting soil faunal biodiversity in the Cape Floristic Region. Collaborators: Drs Louis Deharveng and Anne Bedos, Origine, Structure et Evolution de la Biodiversité, Museum National d'Histoire Naturelle (van Vuuren, Chown).

Assessing abundance and impacts of alien fishes in the Wilderness lakes system. Collaborators: Dr. Werner Ekau, University Bremen, Germany (Weyl).

Assessing impacts and benefits of alien fish introductions in the Amathole region, Eastern Cape. Collaborators: Mr Q Rouhani (Department of Ichthyology and Fisheries Science, Rhodes University); Prof. P Britz (Department of Ichthyology and Fisheries Science, Rhodes University); Prof. J Snowball (Department of Economics, Rhodes University); Prof. N Smit (Department of Zoology, University of Johannesburg); Prof. P Van Zwieten (Wageningen University, Aquaculture and Fisheries Group, Wageningen, The Netherlands); Prof. L Nagelkerke (Wageningen University, Aquaculture and Fisheries Group, Wageningen, The Netherlands); Dr. J. Gambiza (Department of Environmental Science, Rhodes University) (Weyl).

Parasitological and ecological research on South African eels with a focus on alien parasites. Collaborator: Prof. Horst Taraschewski (University Karlsruhe, Department of Zoology) (Weyl).

Hybrid fitness in South African honeybees: the effects of genotype mixing on reproductive traits of workers. Collaborators: Profs Ben Oldroyd and Madeleine Beekman, School of Biological Sciences, University of Sydney, Australia and Mike Allsopp, Bee Research Unit, Plant Protection Research Institute, Agricultural Research Council (Wossler).

Pheromone mediated reproductive dominance hierarchies among pseudo-clonal honeybee workers (*Apis mellifera capensis*) Collaborators: Dr. Stephan Härtel, Department of Animal Ecology and Tropical Biology, University of Würzburg, Germany; Prof. Robin Crewe, Department of Zoology and Entomology, University of Pretoria, SA; Prof. Robin Moritz, Institute for Biology: Molecular Ecology, Martin-Luther University, Halle-Wittenberg, Germany and Dr. Peter Neumann, Swiss Bee Research centre, Switzerland (Wossler).

5 Service rendering

5.1 Objectives

In the external service provision arena, the main goal of the C·I·B is to be valued for excellent, evidence-based, reliable, affordable and impartial service. Clients should always be in a position to follow up on the service they have received in such a way that they derive the full benefit from the C·I·B services available. Whilst the C·I·B does not consider itself a consulting venture, it provides service on the basis of the knowledge it generates in specific

fields and in collaboration with those clients that seek advice from it. In this regard, the quality of the Centre's research, the reputation of its researchers, and the project management skills of its staff all form key elements of its service provision. Research outputs from service provision are a key goal of the activity.

5.2 Progress

5.2.1 National panels and committees

Steering Committee of the South African National Survey of Arachnida (SANSA). Member (Chimimba).

Advisory Board, Centre of Excellence at the Percy FitzPatrick Institute of Ornithology, University of Cape Town. Member (Chimimba).

Board of Trustees, Green Trust. Member (Chimimba).

Institute for the Breeding of Rare and Endangered Mammals South Africa (IBREAM SA). Director (Chimimba).

Adjudication panel, National Science and Technology Forum (NSTF). Member (Chimimba).

Prince Edward Islands Management Committee. Member (Chown).

C.A.P.E. Invasive Alien Animals Working Group. Member (Davies).

SAEON Fynbos Node Liaison committee. Member (Esler).

HERS Advisory Board. Member (Esler).

Fynbos Forum Committee. Member (Esler).

South African Biota Liaison Committee. Member (Esler).

Higher Education Working Group (to support Capacity Building in the Biodiversity Sector). Member (Esler).

Vhembe Biosphere Committee. Member (Foord).

CSIR Natural Resources and the Environment, Working for Water Research Project Reference Panel. Member (Foxcroft).

South African Data Centre for Oceanography (SADCO). Board member (Griffiths)

Biodiversity Scientific Working Group, Dept. Environmental Affairs and Tourism. Member (Griffiths).

AfriOceans Conservation Alliance. Board (Griffiths).

Biodiversity Monitoring Steering Committee, South African National Biodiversity Institute. Member (McGeoch).

Fynbos Node Steering Committee, South African Environmental Observation Network. Member (McGeoch).

Water Research Commission/Working for Water reference group for the project on Impacts of invasions on important ecosystem services. (Richardson).

IUCN Wild Dog Advisory Group of South Africa. Member (Somers).

Zoological Society of Southern Africa. Council Member, Biodiversity portfolio (van Rensburg).

National Science and Technology Forum (NSTF) and the Scientific, Engineering and Technological Societies and Allied Professions Group of South Africa (SETAG). Member (van Rensburg).

Member of the South African National Committee for SCAR (van Vuuren).

Council Member: Zoological Society for Southern Africa (van Vuuren).

Helderberg Nature Reserve Advisory Board committee member (Wossler).

5.2.2 International panels and committees

SCAR Antarctic Treaty System Standing Committee. Chief Officer (Chown).

IUCN SSC, Invasive Species Specialist Group. Member (Foxcroft).

Executive committee of MEDECOS Association, ISOMED. National Representative (Esler).

International Association for Biological Oceanography (IABO). Executive Member and South African National Representative (Griffiths).

Africa Regional Implementation Committee, Census of Marine Life Programme. Chair (Griffiths).

Biodiversity Indicators Partnership 2010 Invasive Species Working Group. Member (McGeoch).

IUCN Species Survival Specialist Group on Invasive Organisms: Member (Richardson).

IUCN Species Survival Specialist Group on Conifers: Member (Richardson).

IUCN Species Survival Specialist Group on Southern African Plants: Member (Richardson).

International Expert Committee to provide scientific, technical and policy guidance to the International Congress on Biological Invasions, July 2010: Member (Richardson).

IUCN/SSC Steering Committee. Member (Samways).

IUCN/SSC/Invertebrate Conservation Sub-Committee. Chair (Samways).

Xerces Society. Counselor (Samways).

Orthopterists' Society. President Elect (Samways).

Zoological Society of London, Foundations of Biodiversity. Co-organizer (Samways).

The IUCN-SSC Re-introduction specialist Group. Member (Somers).

The IUCN-SSC Otter Specialist Group. Member and African Coordinator (Somers).

The IUCN-SSC Pig, Peccary and Hippo Specialist Group. Member (Somers).

Scientific programme committee member for the International Union for the Study of Social Insects congress, Copenhagen, Denmark 2010 (Wossler).

5.2.3 Editorial and refereeing activities

Editor

International

Diversity and Distributions, Editor-in-Chief (Richardson)

Journal of Biogeography, Co-Editor (McGeoch)

National
Koedoe, Editor (Foxcroft)
South African Journal of Wildlife Research. Editor-in-Chief (Somers)

Associate Editor
International
Biodiversity and Conservation (Chimimba)
Biological Invasions (Hui, Le Roux, Richardson)
Diversity and Distributions (Wilson)
Environmental Management (Richardson)
Fire Ecology (van Wilgen)
International Journal of Wildland Fire (van Wilgen)
Journal of Insect Conservation (Samways)
Marine Biology (Griffiths)
Neobiota (Richardson)
PLoS ONE (Somers).

National
South African Journal of Science (van Wilgen)
African Zoology (Weyl).

Editorial Boards
International journals
African Journal of Ecology (Somers)
African Natural History (Griffiths)
Antarctic Science (Chown)
Applied Mathematics and Computational Sciences (Hui)
Arthropod-Plant Interactions, Handling Editor (Johnson)
Austral Ecology (McGeoch)
Biological Reviews of the Cambridge Philosophical Society (Chown)
Conservation Science and Practice (Samways)
Journal of Orthoptera Research (Samways)
Mymecological News (Samways)
Odonatologica (Samways)
Oecologia handling Editor (Johnson)
Polar Biology (Chown)
Proceedings of the Royal Society of London B (Chown)
Smithiana (Griffiths)
The Open Conservation Biology Journal (Foxcroft)
The Open Zoology Journal (Hui).

International book series

Ecology, Biodiversity, and Conservation (Cambridge University Press). Editorial Board Member (Richardson)

Conservation Biology (Cambridge University Press). Editorial Board Member (Richardson).

National journals

African Entomology (Wossler)

African Journal of Aquatic Science (Weyl)

Koedoe (Griffiths, McGeoch)

Navorsinge van die Nasionale Museum, Bloemfontein (Chimimba).

5.2.4 Reviewing

International

Acta Oecologica; *African Journal of Ecology*; *American Journal of Botany*; *American Midland Naturalist*; *American Naturalist*; *Annals of Botany*; *Annals of the Entomological Society of America*; *Aquatic Botany*; *Austral Ecology*; *Australian Journal of Entomology*; *Basic and Applied Ecology*; *Behavioural Ecology and Sociobiology*; *Biodiversity and Conservation*; *Biological Conservation*; *Biological Control*; *Biological Invasions*; *Biology Letters*; *BMC Ecology*; *BMC Evolutionary Biology*; *Bulletin of Entomological Research*; *Community Ecology*; *Comparative Biochemistry and Physiology A*; *Conservation Biology*; *Conservation Genetics*; *Conservation Science and Practice*; *Diversity and Distributions*; *Ecography*; *Ecology*; *Ecological Modelling*; *Ecology Letters*; *Environmental Management*; *Evolution*; *Functional Ecology*; *Global Ecology and Biogeography*; *Global Environmental Change*; *Heredity*; *Human Ecology*; *Hydrobiologia*; *International Journal of Plant Sciences* ; *Journal of Applied Ecology*; *Journal of Applied Entomology*; *Journal of Arid Environments*; *Journal of Biogeography*; *Journal of Chemical Ecology*; *Journal of Ecology*; *Journal of Economic Entomology*; *Journal of Environmental Management*; *Journal of Ethology*; *Journal of Experimental Biology*; *Journal of Experimental Marine Biology and Ecology*; *Journal of Great Lakes Research*; *Journal of Insect Conservation*; *Journal of Insect Science*; *Journal of Mammalogy*; *Journal of Orthoptera Research*; *Journal of Rural and Community Development*; *Journal of Zoology London*; *Marine Biology*; *Methods in Ecology and Evolution*; *Molecular Ecology*; *Molecular Ecology Resources*; *Oecologia*; *Oikos*; *Paleobiology*; *Philosophical Transactions of the Royal Society B*; *Physiological and Biochemical Zoology*; *Plant Biology*; *PNAS*; *Polar Biology*; *Proceedings of the Royal Society B*; *Science*; *Trends in Ecology and Evolution*; *Water Research*; *ZooTaxa.*

National

African Entomology; *African Invertebrates*; *African Journal of Aquatic Science*; *African Zoology*; *Annals of the Transvaal Museum*; *Koedoe*; *South African Journal of Botany*; *South African Journal of Science*; *South African Journal of Wildlife Research.*

Grant reviews for external bodies

Czech Science Foundation (Clusella-Trullas, Le Roux)
Peoples trust for Endangered Species. Applicant assessment (Somers)
Royal Society of New Zealand; Marsden Fund: referee for proposal (Richardson)
SANPAD (Esler)
Water Research Commission (Esler).

Appointment reviews and committees

Australian Academy of Science; nomination for fellowship: referee for candidate (Richardson)
Council for Higher Education: audit process for the University of Limpopo (Chimimba)
Santa Clara University, USA: promotion assessment (Chown)
University of KwaZulu-Natal: promotion assessment (Richardson)
University of Leuven: professorial appointment (Johnson)
University of Texas at Austin, USA; professorial appointment: referee for candidate (Richardson)
University of Waterloo, Canada; early researcher award: referee for candidate (Richardson).

Conferences/workshops organized

Human-mediated introductions of Australian Acacia species— a global experiment in biogeography, Stellenbosch, South Africa, October 2010. Organised by Dave. Richardson, Jaco Le Roux, John Wilson (SANBI/C·I·B), Fiona Impson (UCT/PPRI) and Christy Momberg.

Invasion science 101 - progress and challenges. A foundation course in biological invasions: recent advances and traditional tools, Howick, Kwazulu-Natal, South Africa, October 2010. Organised by David Richardson, John Wilson (SANBI/ C·I·B), Ingrid Nänni (SANBI) and Christy Momberg.

Consulting and other services rendered

Chown, S.L. and Terauds, A. (Eds.). 2010. *Current knowledge for reducing risks posed by terrestrial non-native species: towards an evidence-based approach.* Working Paper 6, prepared for SCAR and Australia, to the XXXIII Antarctic Treaty Consultative Meeting, Punta del Este, Uruguay, 4 pp.

Chown, S.L. 2010. *Biological prospecting in the Antarctic region: a conservative overview of current research.* Working Paper 2, prepared for SCAR, to the XXXIII Antarctic Treaty Consultative Meeting, Punta del Este, Uruguay, 4 pp.

Gremmen, N.J.M., Huiskes, A.H.L. and Chown, S.L. (Eds.). 2010. *Preliminary results from the International Polar Year Programme: Aliens in Antarctica.* Working Paper 4, prepared for SCAR, to the XXXIII Antarctic Treaty Consultative Meeting, Punta del Este, Uruguay, 3 pp.

McGeoch, M.A., Spear, D., Marais, E., Kleynhans, E. (2009). *Development and implementation of the Invasive Alien Species Indicator for the Convention on Biological Diversity's 2010 Target*. GEF 2010 Biodiversity Indicators Partnership Project for the Global Invasive Species Programme (continuous reporting).

Irlich, U. & Chown, S.L. 2010. Invasive aliens. Section 3.4 In: South Africa's Second National Contribution to the United National Framework Convention on Climate Change (UNFCCC). Submitted August 2010.

Terauds, A. and Chown, S.L. 2010. *Biodiversity-based evaluation of the environmental domains analysis.* Working Paper 3, prepared for SCAR, to the XXXIII Antarctic Treaty Consultative Meeting, Punta del Este, Uruguay, 5 pp.

6 Gender impact of research

Equity in gender remains an important objective of the C·I·B in all of its activities. Of the 21 non-academic and six academic staff employed through the C·I·B hub in 2010, 21 are female and an additional woman is employed in the second hub at the University of Pretoria. The Core Team Membership of the C·I·B includes seven women. Sixty percent of the C·I·B's students and post-docs are female. Ten out of the 16 students who graduated in 2010 are female, including Monique Maseng, Martina Treurnicht and Manquai Kraai (M.Sc.), and Natalie Haussmann and Nicola van Wilgen (Ph.D.). Five women honours students graduated, two at North West University, and three at University of Venda. Much of the social aspects of the C·I·B research includes in its focus the impact of interventions, such as those by the Working for Water programme, on women. The role of women in the South African Antarctic programme has also continued to be a focus of work in two major areas. First, ongoing scientometric work supported by the Antarctic Legacy Project is giving specific attention to the extent to which the gender of authors has changed in the programme through time. This work is ongoing and involves the difficult task of identifying author gender, a variable usually not available in standard databases. Second, much attention was given to understanding the early women pioneers of research at the Prince Edward Islands. The information is captured in the chapter on the history of the islands in the popular book, by Terauds and colleagues, describing their history and natural history.

7 Human resources

7.1 Core team members

Name	Citizenship	Institution	Gender	Race	Time spent working in CoE (%)
Prof. Steven Chown	South Africa	SU	M	W	100
Prof. David Richardson	South Africa	SU	M	W	100
Ms. Sarah Davies	South Africa	SU	F	W	100
Prof. Chris Chimimba	South Africa	UP	M	B	25
Dr. Susana Clusella-Trullas	Spain	SU	F	W	100
Prof. Karen Esler	South Africa	SU	F	W	35
Dr. Stefan Foord	South Africa	UniVen	M	W	75
Dr. Llewellyn Foxcroft	South Africa	SANParks	M	W	5
Prof. Charles Griffiths	South Africa	UCT	M	W	20
Dr. Cang Hui	China	SU	M	A	100
Prof. Steven Johnson	South Africa	UKZN	M	W	20
Dr. Jaco le Roux	South Africa	SU	M	W	100
Prof. Melodie McGeoch	South Africa	SANParks	F	W	25
Dr. Augustine Niba	Cameroon	WSU	M	B	15
Dr. Heidi Prozesky	South Africa	SU	F	W	20
Dr. Victor Rambau	South Africa	SU	M	B	25
Prof. Michael Samways	South Africa	SU	M	W	25
Prof. Michael Somers	South Africa	UP	M	W	25
Prof. Berndt van Rensburg	South Africa	UP	M	W	50
Prof. Bettine van Vuuren	South Africa	SU	F	W	35
Dr. Brian van Wilgen	South Africa	CSIR	M	W	5
Dr. Olaf Weyl	South Africa	SAIAB	M	W	5
Dr. John Wilson	South Africa	SU	M	W	100
Prof. Theresa Wossler	South Africa	SU	F	W	25

7.2 Post-doctoral associates

Name	Citizenship	Institution	Race	Gender	Time spent working in CoE (%)
Dr Cécile Berthouly-Salazar	France	SU	W	F	66
Dr. Brigitte Braschler	UK	SU	W	F	100
Dr. Alana Den Breeyen	South Africa	Su	W	F	10
Dr. Mirijam Gaertner	Germany	SU	W	F	100
Dr. Rainer Krug	Germany	SU	W	M	100
Dr. Peter le Roux	South Africa	SU	W	M	100
Dr. Jennifer Lee	UK	SU	W	F	100
Dr. Denise Mager	Austria	SU	W	F	100
Dr. Marc Rius	Spain	UCT	W	M	100
Dr. Justine Shaw	Australia	SU	W	F	25
Dr. Dian Spear	UK	SU	W	F	100
Dr. Christopher Weldon	Australia	SU	W	M	66
Dr. Feng Zhang	China	SU	B	M	100

7.3 Students supported

Name	Citizenship	Institution	Race	Gender	Status
Honours/4 year B. degree:					
Ms. Amy Liu	SA	SU	B	F	Continuing
Mr. Anathi Magadlela	SA	WSU	B	M	Continuing
Ms. Malesolo Thabitha Magoele	SA	UniVen	B	F	Completed
Mr. Mashudu Mashau	SA	UniVen	B	M	Completed
Ms. Vanessa Matukana	SA	UniVen	B	F	Completed
Mr. Fani Nyembezi	SA	WSU	B	M	Continuing
Ms. Gadifele Rebecca Thamaga	SA	UNW	B	F	Completed
Ms. Kgomotso Emily Thomas	SA	UNW	B	F	Completed
Ms. Daisy Thononda	SA	UniVen	B	F	Completed

Name	Citizenship	Institution	Race	Gender	Status
Masters (M.A. and M.Sc.):					
Ms. Jessica Allen	SA	SU	W	F	Continuing
Ms. Katelyn Faulkner	UK	SU	W	F	Continuing
Mr. Muhammed Gardee	SA	SU	B	M	Continuing
Ms. Michelle Gibson	USA	SU	W	F	Continuing
Mr. Anton Hough	SA	SU	W	M	Completed
Ms. Wilna Jansen	SA	UP	W	F	Continuing
Ms. Rolanda Julius	SA	UP	B	F	Continuing
Ms. Haylee Kaplan	SA	SU	W	F	Continuing
Ms. Elsje Kleynhans	SA	SU	W	F	Continuing
Mr. Dickson Mazibuko	Malawi	SU	B	M	Continuing
Ms. Nokuthula Mbanyana	SA	SU	B	F	Continuing
Ms. Matthew Miles	SA	UKZN	W	M	Continuing
Mr. Jason Mingo	SA	SU	W	M	Continuing
Mr. Caswell Munyai	SA	UniVen	B	M	Continuing
Mr. Thabisisani Ndhlovu	Zimbabwe	SU	B	M	Continuing
Ms. Nolubabalo Tantsi	SA	UP	B	F	Continuing
Ms. Megan Nowell	SA	SU	W	F	Continuing
Ms. Madeleine Ramantswana	SA	SU	B	F	Continuing
Mr. Andrew Rogers	USA	SU	W	M	Continuing
Ms. Azwinndini Sebola	SA	UniVen	B	F	Continuing
Mr. Matthys Strydom	SA	SU	W	M	Continuing
Ms. Martina Treurnicht	SA	SU	W	F	Completed
Ms. Julia Francis van der Merwe	SA	SU	W	F	Continuing
Ms. Waafeka Vardien	SA	SU	B	F	Continuing

Name	Citizenship	Institution	Race	Gender	Status
M.Sc.-Ph.D. upgrade:					
Ms. Genevieve Thompson	SA	SU	W	F	Continuing
Ms. Nicola van Wilgen	SA	SU	W	F	Completed

Name	Citizenship	Institution	Race	Gender	Status
Ph.D.:					
Mr. Ryan Blanchard	SA	SU	B	M	Continuing
Ms. Marguerite Blignaut	SA	SU	W	F	Continuing
Mr. Bernard Coetzee	SA	SU	W	M	Continuing
Mr. Andrew Davies	SA	UP	W	M	Continuing
Ms. René Gaigher	SA	SU	W	F	Continuing
Ms. Tanya Haupt	SA	SU	B	F	Continuing
Ms. Sanet Hugo	SA	UP	W	F	Continuing
Ms. Natalie Haussmann	SA	SU	W	F	Completed
Ms. Charlene Janion-Scheepers	SA	SU	W	F	Continuing
Ms. Candice Lyons	SA	SU	W	F	Continuing
Mr. Greg McClelland	Canada	SU	W	M	Continuing
Mr. Matthew McConnachie	SA	Rhodes	W	M	Continuing
Ms. Mandisa Mgobozi	SA	UKZN	B	F	Continuing
Ms. Palesa Natasha Mothapo	SA	SU	B	F	Continuing
Mr. James Mugabe	Zimbabwe	SU	B	M	Continuing
Ms. Joice Ndlovu	Zimbabwe	SU	B	F	Continuing
Ms. Ethel Phiri	SA	SU	B	F	Resigned
Ms. Andriamihaja Ramanantoanina	Madagascar	SU	B	F	Continuing
Mr. Sheunesu Ruwanza	Zimbabwe	SU	B	M	Continuing
Mr. Jeremy Shelton	SA	SU	W	M	Continuing
Mr. Farai Tererai	Zimbabwe	SU	B	M	Continuing
Ms. Anne Treasure	SA	SU	W	F	Continuing
Ms. Charmaine Uys	SA	UCT	W	F	Continuing
Ms. Lize-Marie van der Watt	SA	SU	W	F	Continuing
Mr. Tsungai Zengeya	Zimbabwe	UP	B	M	Continuing
Mr. Matthew Zylstra	Australia	SU	W	M	Continuing

7.4 Collaborators (loosely involved with CoE)

See networking

7.5 Administrative staff

Name	Inst.	Position	Race	Gender
Ms. Sarah Davies	SU	Deputy Director: Operations	W	F
Ms. Karla Coombe-Davis	SU	Principal Technical Officer: Databases	W	F
Ms. Josephine De Mink	SU	Administrative Assistant	B	F
Ms. Dorette Du Plessis	SU	Chief Technical Officer: Outreach	W	F
Ms. Anel Garthwaite	SU	PA to S.L. Chown	W	F
Ms. Ulrike Irlich	SU	Researcher: Climate Change	W	F
Ms. Keafon Jumbam	SU	Technical Officer: Iimbovane Outreach Project	B	F
Ms. Thembile Khoza	SU	Technical Officer: Long Term Projects	B	F
Ms. Elizabeth Kleynhans	SU	Researcher: GISP	W	F
Ms. Suzaan Kritzinger-Klopper	SU	Senior Technical Officer	W	F
Ms. Tlou Manyelo	Su	Technical Officer	B	F
Ms. Christy Momberg	SU	PA to D.M. Richardson	W	F
Ms. Rhoda Moses	SU	Administrative Assistant	B	F
Ms. Erika Nortje	SU	First Technical Officer: Lab Management	W	F
Mr. Mawethu Nyakatya	SU	Senior Technical Officer: Project Management	B	M
Ms. Asanda Phiri	SU	Field Assistant: Marion Island	B	F
Ms. Charlene Janion-Scheepers	SU	Technical Officer: Norway-Sweden Projects	W	F
Ms. Dora Scott	SU	Technical Officer: Antarctic Legacy Project	W	F
Ms. Nicole Southgate	SU	Assistant Technical Officer: Iimbovane	B	F
Ms. Chantal Strumpfer	UP	Technical Officer and Administrative Assistant	W	F
Ms. Mathilda van der Vyver	SU	Administrative Officer	W	F

7.6 Resources in the marketplace

Graduate name	Level	Supervisor	Position/Organisation
Dr. Natalie Haussmann	Ph.D.	Prof. McGeoch	Lecturer, Dept Geography, Geoinformatics and Meteorology, University of Pretoria
Ms. Manqai Kraai	M.Sc.	Prof Kerley	Intern, SAIAB
Dr. Rembuluwani Magoba	Ph.D.	Prof. Samways	Freshwater Ecologist and Entomologist, Southern Waters Ecological Research and Consulting cc.
Mr. Tshililo Ramaswiela	M.Sc.	Prof. Chown	SAEON, Kimberley
Dr. Justine Shaw	Post-Doc	Prof. Chown	Australian Antarctic Division
Dr. Nicola van Wilgen	Ph.D.	Prof Richardson	Global Change Scientist, Science Services: Cape Research Centre, SANParks

8 Outputs

8.1 Books

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8.2 Book chapters

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8.4 Published conference proceedings

Cooper, J. (2010). Declaring international protected areas in UK Crown Dependencies and Overseas Territories: the role of the Ramsar and World Heritage Conventions. In: *Making the Right Connections: a Conference on Conservation in UK Overseas Territories, Crown Dependencies and other Small Island Communities*. Grand Cayman. (eds. Pienkowski, M., Cheesman, O., Quick, C. and Pienkowski, A.). pp. 212-220.

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Su, M. and Hui, C. (2010). An eco-epidemiological system with infected predator. In: *Third International Conference on Biomedical Engineering and Informatics (BMEI 2010)*. **XI,** pp. 2390-2393.

Wilson, J.R.U. (2010). Eradication and monitoring of Australian Acacias in South Africa as part of an EDRR program, can species with long-lived seed banks be eradicated. In: *2nd International Workshop on Invasive Plants in the Mediterranean Type Regions of the World*. Trabzon, Turkey. p. 54.

8.5 Published conference abstracts

Davies, S.J., McGeoch, M.A. and Clusella-Trullas, S. (2010). Distribution and habitat preferences of the painted reed frog *Hyperolius marmoratus* Rapp in its novel range in the Western Cape Province of South Africa. In: *African Amphibian Working Group 14*. *African Herp News*. **51,** p. 32.

Esler, K.J. (2010). Arid ecosystems and academia: How competition and facilitation interactions shape community structure and function. In: *Abstracts. South African*

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Esler, K.J. (2010). Restoring South African Mediterranean-type ecosystems following alien plant invasion. In: *7th SER European Conference on Ecological Restoration*. Avignon, France. p. 298.

Mokotjomela, T.M., Musil, C.F. and Esler, K.J. (2010). Are fleshy fruits of alien shrubs a preferred food resource for avian frugivores in the Cape Floristic Region? In: *Abstracts. South African Association of Botanists – Annual meeting 2010*. *South African Journal of Botany*. **76,** p. 399.

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Treurnicht, M., Esler, K.J. and Gaertner, M. (2010). Impacts of ploughing and introduction of commercial Fynbos species on the diversity of sandstone Fynbos on the Agulhas Plain, South Africa. In: *Abstracts. South African Association of Botanists – Annual meeting 2010*. *South African Journal of Botany*. **76,** p. 416.

8.6 Products / Artifacts / Patents

None

8.7 Conferences / meetings attended

8.7.1 Plenary/Keynote Presentations

International

Chown, S.L. Biodiversity change: an unintended legacy. First Martha T. Muse Lecture. *Fourth International Polar Year, Oslo Science Conference, Norway, June 2010*

Chown, S.L. Biodiversity and Conservation in the Antarctic. Plenary, lunchtime address. *XXXI SCAR Delegates Meeting, Buenos Aires, August 2010*

Chown, S.L. Temporal changes in transformed landscapes: a southern systems perspective. *Biological diversity in a changing world. A Royal Society 350th Anniversary Symposium, London, October 2010*.

National

Chown, S.L. Changing with biodiversity change. *Keynote address at the National Research Foundation's President's Awards Function, Cradle of Humankind, Johannesburg, September 2010*

Chown, S.L. Establishing and maintaining long term ecological research: projections, goals, logistics and outcomes. *Plenary address at the SAEON Summit 2010, Kirstenbosch, Cape Town, October 2010*

Esler, K.J. Arid ecosystems and academia: How competition and facilitation interactions shape community structure and function. *Plenary address at South African Association of Botanists 36th Annual meeting, Potchefstroom, January 2010*

Hui, C. How to quantify species assemblages? *African Institute of Mathematics Sciences (AIMS), Cape Town, South Africa, 2010.*

8.7.2 Oral presentations

International

Brettschneider, H., Chimimba, C.T. and Bastos A.D.S., Seasonal variation of *Bartonella* infections in the Namaqua rock mouse (*Micaelamys namaquensis*) from Ezemvelo Nature Reserve, South Africa. *4th International Conference on Rodent Biology and Integrated Pest Management (ICRBM), Bloemfontein April 2010***.**

Clusella-Trullas, S., Chown, S.L., Blackburn, T. and Terblanche J.S. Global patterns of thermal physiology in reptiles: from small to large scales. *Society for Experimental Biology Annual Main Meeting, Prague, 30th June - 3rd July 2010.*

Davies, S.J., McGeoch, M.A. and Clusella-Trullas, S. (2010) Distribution and habitat preferences of the painted reed frog *Hyperolius marmoratus* in the Western Cape. *14th meeting of the African Amphibian Working Group (AAWG14), Monkey Valley, Cape Town, 2 - 4 June*.

Esler, K.J. Restoring South African Mediterranean-type ecosystems following alien plant invasion. *7th SER European Conference on Ecological Restoration, Avignon, France, August, 2010.*

Foord, S.H. Towards a standardized and optimized protocol for rapid biodiversity assessments: spider species richness and assemblage composition in two savanna vegetation types. *18th International Congress of Arachnology. Siedlce, Poland, Jul 11-17, 2010.*

Gallagher, R., Leishman, M., Miller, J. and Le Roux, J.J. Genome size as a predictor of invasion success and trait variation in Australian acacias. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Harris, C., Leishman, M., Lowe, A., Le Roux, J.J. and Dormontt, E. Evidence for evolutionary change and introduction history in invasive Australian acacias *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Hough, J.A. and Prozesky, H.E. Creating independent entrepreneurs? A multi-site case study of beneficiaries' aspirations for permanent employment within the South African Working for Water programme. *6th Neobiota Conference, Copenhagen, September 2010.*

Hui, C., D.M. Richardson, M.P. Robertson, C.J. Yates and Wilson, J.R.U. Macroecology meets invasion ecology: linking native distribution of Australian acacias to

invasiveness. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Huiskes, A., Gremmen, N., Bergstrom, D., Hughes, K., Lee, J., Chown, S.L., Imura, S., Tsujimoto, M., Lebouvier, M., Frenot, Y., Steenhuisen, F., Van de Vijver, B. Aliens in Antarctica, quantifying plant and animal propagules inadvertently carried into the Antarctic. *Scientific Committee on Antarctic Research (SCAR) Open Science Conference, Buenos Aires, Argentina, August 2010.*

Jansen Van Vuuren, B. Evidence from multiple species for dispersal among the Southern Ocean islands and Antarctica before the Last Glacial Maximum. SCAR XXXI and Open Science Conference, Buenos Aires, Argentina, August 2010.

Kull, C.A, Shackleton, C., Cunningham, P., Ducatillon, C., Dufour Dror, J-M., Esler, K., Friday, J.B., Gouveia, A.C., Griffin, R., Marchante, E., Midgley, S., Pauchard, A., Rangan, H., Richardson, D., Rinaudo, T., Tassin, J., Urgenson, L., von Maltitz, G., Zenni, R., Zylstra, M. Adoption, use, and perception of Australian acacias around the world. *Human-mediated introductions of Australian Acacia species- a global experiment in biogeography, Stellenbosch, October 2010.*

Le Roux, J., Richardson, D.M., Wilson, J.R.U., Thompson, G., Ndlovu, J.N. Brown, G. and Byrne, M. Phylogeographic and cytogenetic consequences of different introduction histories of invasive Australian Acacia and Paraserianthes species (Fabaceae) in South Africa. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

McGeoch, M.A. McGeoch, M.A., Lee, J.A. and Chown, S.L. Application of the global Invasive Alien Species Indicator in Antarctica. *International Polar Year Oslo Science Conference, Session: Invasive and introduced species in polar environments, Polar Science. Lillestrom-Oslo, June 2010.*

Medger, K., Chimimba, C.T. and Bennett, N.C.; Changes in periventricular kisspeptin-immunoreactivity in seasonally breeding male and female spiny mice (*Acomys spinosissimus*) from South Africa. *4th International Conference on Rodent Biology and Integrated Pest Management (ICRBM), Bloemfontein April 2010.*

Morris, T., Cramer, M., Barger, N., Esler, K. and Jacobs, S. Functional traits linked to resource acquisition and use that promote successful invasions by Australian *Acacia* species: The case study of South Africa. *Human-mediated introductions of Australian Acacia species- a global experiment in biogeography, Stellenbosch, October 2010.*

Prozesky, H.E. and Boshoff. Bibliometrics as a tool for measuring gender-specific research performance: An example from South African invasion ecology. *The 2nd International Conference on Science in Society, Madrid, November 2010.*

Richardson, D., Carruthers, J., Hui, C., Impson, F., Maslin, B., Robertson, M., Rouget, M., Le Roux, J., and Wilson, J. Human-mediated introductions of Australian Acacia species—a global experiment in biogeography. *Human-mediated introductions of*

Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.

Richardson, D.M. Biological invasions in a changing world - A (very) brief introduction to invasion science. *Workshop on biological invasions - Towards general rules across taxa, University of Bern, Muerren, Switzerland, August, 2010. http://sites.google.com/site/biologicalinvasions/home.*

Rodrıguez-Echeverrıa S., Le Roux, J.J., Ndlovu, J. Jack of all trades and master of many? How does associated rhizobial diversity influence the colonization success of Australian *Acacia* species? *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Shaw, J.D., Sinclair, B., Webb, E. and Chown, S.L. Albatrosses and caterpillars: the use of stabkle isotopes in understanding ecosystem engineering in the terrestrial sub-Antarctic. *Scientific Committee on Antarctic Research (SCAR) Open Science Conference, Buenos Aires, Argentina, August 2010.*

Somers, M.J. and Van der Westhuizen, R. The black and white of rhino conservation: Why has the conservation of rhino is South Africa been so effective, and can it continue. *Society for Conservation Biology meeting, Edmonton, Canada, July 2010.*

Tantsi, N. Response of ant communities to an alien invasive plant (*Chromolaena odorata*) - the effect of temporal variation in invasion and clearing. *8th IOBC International Workshop on Biological Control and Management of* Chromolaena odorata *and Other* Eupatorieae. *Nairobi, November 2010.*

Terauds, A. and Chown, S.L. Conservation biogeography of the Antarctic. Past perspectives and current approaches. *Scientific Committee on Antarctic Research (SCAR) Open Science Conference, Buenos Aires, Argentina, August 2010.*

Thompson, G.D., Le Roux, J.J., Millar, M.A., Bellstedt, D.U., Richardson, D.M., Wilson, J.R.U. Molecular research as a tool for managing biological invasions: *Acacia saligna* as a case study: *2nd International Workshop on Invasive Alien Plants in Mediterranean Type Regions of the World, Trabzon, Turkey, August 2010.*

Thompson, G.D, Robertson, M., Le Roux, J.J., Richardson, D.M. and Wilson, J.R.U. Combining morphology, molecules and ecological niche models to improve the prediction of invasive plant species ranges. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Treasure, A.M. and Chown, S.L. Range limits and abundance structure of an invasive springtail (*Pogonognathellus flavescens*) on Marion Island. *Research symposium in applied population biology, NERC Centre for Population Biology and Imperial College London Division of Biology at Silwood Park, UK, June 2010.*

Urgenson, L. Prozesky, H.E. and Esler, K.J. Multi-stakeholder assessment of Working for Water's approach to clearing invasive alien plants on private land, South Africa. *North*

American Regional Meeting of the International Association for the Study of the Commons (IASC), Arizona State University, September–October 2010.

Van Wilgen, B., Dyer, C., Hoffmann, J., Ivey, P., Le Maitre, D., Richardson, D., Rouget, M., Wannenburgh, A. and Wilson, J. A strategic approach to the integrated management of Australian *Acacia* species in South Africa. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Van Wilgen, B.W., Dyer, C, Hoffmann, J.H., Ivey, P., Le Maitre, D.C., Richardson, D.M., Rouget, M., Wannenburgh, A. and Wilson, J.R.U. A strategic approach to the integrated management of Australian acacias in South Africa. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Wilson, J. Quarantine, eradication, containment, and biological control: global efforts to control Australian Acacia species before they become widespread. *Human-mediated introductions of Australian Acacia species—a global experiment in biogeography, Stellenbosch, October 2010.*

Wilson, J., Kaplan, H., Mazibuko, D., de Smidt, J., Zenni, R. and Van Wyk, E. Eradication and monitoring of Australian Acacias in South Africa as part of an EDRR program *2nd International Workshop on Invasive Plants in the Mediterranean Type Regions of the World. Trabzon, Turkey, August 2010.*

National

Do Linh San, E. and Somers, M.J. Species co-existence in an assemblage of small African carnivores: project presentation and preliminary data. *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Do Linh San, E., Nqinana, A. and Somers, M.J. Diet of the marsh mongoose (*Atilax paludinosus*) in the Andries Vosloo Kudu Nature Reserve (Eastern Cape). *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Matolengwe, T., Somers, M.J. and Do Linh San, E. Diet of genets (*Genetta* spp.) in the Andries Vosloo Kudu Nature Reserve (Eastern Cape). *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010***.**

Mbatyoti, O.A., Somers, M.J. and Do Linh San, E. The diet of the Cape grey mongoose (*Galerella pulverulenta*) in the Albany Thicket Biome (Eastern Cape). *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Mokotjomela, T.M., Musil, C.F. and Esler, K.J. Are fleshy fruits of alien shrubs a preferred food resource for avian frugivores in the Cape Floristic Region? *South African Association of Botanists 36th Annual meeting, Potchefstroom, January 2010*.

Munyai, T.C., Foord, S.H., Baxter, R. How fast can you climb a mountain? Climate change, ant assemblages and a centre of endemism. *SAEON Graduate Student Network (GSN), Port Elizabeth, March 2010.*.

Munyai, T.C., Foord, S.H., Baxter, R. How fast can you climb a mountain? Climate change, ant assemblages and a centre of endemism. *SAEON 2010 summit, Cape Town, October, 2010***.**

Ndhlovu, T., Milton S.J., and Esler K.J. Impact of mesquite (*Prosopis* spp) invasion and clearing on the grazing capacity of semi-arid Nama Karoo rangeland, South Africa. *45th Annual Congress of the Grassland Society of Southern Africa, Kimberley, July 2010.*

Nowell, M.S., Le Maitre, D.C., Esler, K.J., and Kalwij, J.M., Kernels, convolution and tasseled cap: methods for mapping and monitoring land use and invasive vegetation on the Agulhas Plain. *Fynbos Forum 2010, Citrusdal, August 2010*.

Van der Merwe, M., Van Vuuren, J. and Hui, C. Games on networks. *South African Society for Operations Research Conference (ORSSA). Limpopo, September, 2010.*

Weyl, O.L.F., Taraschewki, H. and Parker, D. 2010. An assessment of the risks of parasite transfers associated with live imports of *Anguilla mossambica* from Madagascar. *The Southern African Society of Aquatic Scientists: Aquatic biodiversity and climate change – an arid region perspective*. *Augrabies Falls, June 2010.*

8.7.3 Poster presentations

International

Lee, J.E., Van Vuuren, B.J., Convey, P. and Chown, S.L. Genetic structure of microarthropod populations in East and West Antarctica – biosecurity implications. *Scientific Committee for Antarctic Research (SCAR) Open Science Conference, Buenos Aires, Argentina, August 2010.*

Mead, A. and Griffiths, C.L. Climate and bioinvasions: Drivers of long-term community change along the South African coast? *Oceans Past lll Dublin, Ireland November 2010.*

Mothapo, N.P. and Wossler, T.C. (2010). We are family – Argentine ants living in harmony! *Proceedings of the XVI International Congress of IUSSI*, Copenhagen, Denmark. p. 313.

Ndlovu, J., Le Roux., J.J., Wilson, J.R.U. and Richardson, D.M. Genetic diversity of rhizobia nodulating *Acacia pycnantha*. *Student Conference on Conservation Science (SCCS-NY), New York, USA, November 2010.*

Nowell, M.S., Le Maitre, D.C. and Esler, K.J. Determining the hydrological benefits of clearing invasive alien vegetation on the Agulhas Plain, South Africa. *ESA Living Planet Symposium, Bergen, Norway, June 2010.*

Treasure, A.M. and Chown, S.L. Environmental changes as a driver of weevil body size on the Prince Edward Islands. *Scientific Committee for Antarctic Research (SCAR) Open Science Conference, Buenos Aires, Argentina, August 2010.*

National

Bashant, J., Dalerum, F., Swanepoel, L. and Somers, M.J. Camera-trapping brown hyena in South Africa: Is abundance affected by the presence of lion? *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Isaacs, L., Swanepoel, L. and Somers, M.J. Estimating African civet (*Civettictis civetta*) densities using camera trap data from other carnivore studies. *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Ndhlovu, T., Milton, S.J. and Esler, K.J. Impact of mesquite (*Prosopis* spp) invasion and clearing on the grazing capacity of semi-arid Nama Karoo rangeland, South Africa. *45th Annual Congress of the Grassland Society of Southern Africa, Kimberley, July 2010.*

Nowell, M.S., Le Maitre, D.C., Esler, K.J. and Kalwij J. M. Determining the hydrological benefits of clearing invasive alien vegetation on the Agulhas Plain. *SAEON Summit, Cape Town, South Africa, October 2010.*

Ramanantoanina, A., Hui, C. and Ouhinou, A. The effect of predator pursuit and prey evasion on the predator-prey dynamics. *South African Mathematical Society (SAMS) Annual Meeting, Pretoria, South Africa, November 2010.*

Rebelo, A.R., Le Maitre, D., Esler, K.J. and Cowling, R.M. A hydrological study of the Kromme River System, Eastern Cape. *Fynbos Forum Conference, Citrusdal, August 2010.*

Rebelo, A.R., Le Maitre, D., Esler, K.J. and Cowling, R.M. A hydrological study of the Kromme River System, Eastern Cape. *South African Environmental Observation Network (SAEON) Summit, October 2010.*

Strydom, M., Esler, K.J., and Wood, A.R. Seed bank status and dynamics of *Acacia saligna* at two sites in the Western Cape South Africa. *South African Association of Botanists 36th Annual meeting, Potchefstroom, January 2010.*

Swanepoel, L., Dalerum, F., Somers, M.J. and Van Hoven, W. Density of leopards (*Panthera pardus*) in the Waterberg Biosphere as determined by camera trapping. *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Tantsi, N. and Somers, M.J. Response of ant communities to an alien invasive plant (*Chromolaena odorata*) - the effect of temporal variation in invasion and clearing. *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

Treurnicht M., Esler, KJ. and Gaertner, M. Impacts of ploughing and introduction of commercial fynbos species on the diversity of sandstone fynbos on the Agulhas Plain,

South Africa. *South African Association of Botanists 36th Annual meeting, Potchefstroom, January 2010.*

Van Tonder, G.J., Perold, V., Somers, M.J. and Druce, D. The decline of the greater kudu *Tragelaphus strepsiceros* in the Hluhluwe-iMfolozi Park. *Southern African Wildlife management Association annual symposium Buffelspoort, September 2010.*

8.8 Other relevant outputs

8.8.1 Popular articles and talks

Articles

Anoniem. 2010. Is dit dalk jy hierdie? *Weg!* November 2010, pp. 17.

Anoniem. 2010. Skrywer vereer. *Landbouweekblad*, Januarie 2010, pp. 72.

Anonymous. 2010. C·I·B professor becomes world's most productive author on invasive species. *Technical Association of the Pulp and Paper Industry of Southern Africa,* March 2010, pp. 6.

Anonymous. 2010. C·I·B professor world's most productive author on invasive species. *Wood SA and Timber Times,* April 2010, pp. 8.

Anonymous. 2010. Giant sables still under threat. *Farming SA*, November 2010, pp. 38.

Anonymous. 2010. Help! Memorabilia wanted for heritage project. *SA Shipping News,* September 2010, pp.36.

Anonymous. 2010. Marine organisms have spread to other oceans. *Fishing Industry News Southern Africa*, April 2010, pp. 22.

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Chown, S.L. Macrophysiology – an approach to understanding the impacts of environmental change. *Invited speaker at the British Antarctic Survey, Cambridge, United Kingdom, April 2010.*

Foxcroft, L.C. Invasive alien species: research and management in Kruger National Park. *Organisation for Tropical Studies, Skukuza, Kruger National Park.*

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Weyl, O.L.F. Invasive fish distributions, ecology and impacts. *C·I·B Annual Research meeting, Stellenbosch University, November 2010.*

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Wilson, J. R. Invasives of the Floral Kind. *Cape Nature History Club, Cape Town, September 2010.*

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8.9 NRF service provision

8.9.1 Rating and project proposal reviews

Focus Area and Panel reviews

Conservation and Management of Ecosystems and Biodiversity project review (Chimimba, Foxcroft)
Biological invasions (Van Rensburg)
South Africa–Argentina Science and Technology Research Cooperation (Le Roux)
Knowledge Fields Development, South African Biosystematics Initiative (Rambau, Weyl)

Competitive Programme for Rated Researchers

Somers (1)

Research Scholarship Evaluations

Esler (14)

Rating Reviews

Chown (1), Griffiths (2), Hui (1), Richardson (1), Somers (1), van Vuuren (1), van Wilgen (2), Weyl (1)

Total number of reviews completed: 31

8.9.2 Panel and committee service

NRF Rating Assessment Panel: Plant Sciences (Esler)
Seachange Advisory Panel (Griffiths)

8.9.3 Other

Coordinated the equipment purchasing and lab moving on Marion Island via the appointment and supervision of Ms. S. Durandt. Service to NRF/DST/DEA on SANAP Programme (Chown).

8.10 Media interactions

8.10.1 Newspaper articles

Anoniem. 2010. Augsburg leerders help Stellenbosch navorsers met mierstudie. Ons Kontrei, 16 Julie 2010.

Anoniem. 2010. Dis my wêreld. Tygerburger- Eersterivier/Blue Downs. 25 Augustus 2010.

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Anoniem. 2010. ‘Jou 4x4 en plasma-tv verhit aarde. Gletser op SA eiland smelt - prof’ Beeld, 18 September 2010.

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Blaine, S. 2010. Stellenbosch scientist honoured. Business Day, 14 June 2010.

Bonthuys, J. 2010. Biodiversiteitsverliese steeds nie stopgesit. Volksblad, 17 Mei 2010.

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Bonthuys, J. 2010. Slaapsiekte kan skadu gooi oor Suider-Afrika. Volksblad, 3 Augustus 2010.

Brand, L. 2010 Diazvillers verdien mikroskoop vir skool. Weslander, 5 Augustus 2010.

Duvenage, E. 2010. Akasias se invloed bekyk. Die Burger (Landbou), 15 Oktober 2010.

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8.10.2 Newsletters

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Chown, S.L. 2010. Interviewed on 702 Talk Radio by Jenny Crwys-Williams about invasive alien earthworms, 29 November 2010.

Chown.S.L. Interviewed for Earth Science on SAFM, concerning the C·I·B, 16 September 2010.

Davies, S.J. Interviewed for Earth Science on SAFM, concerning her research on the locally invasive Painted Reed Frog, 16 September 2010.

Du Plessis, D. Interviewed for Africa Midday, a news programme of Channel Africa, concerning the Iimbovane Outreach Project, 10 September 2010.

Foxcroft, L. Interviewed for Earth Science on SAFM, concerning the UNESCO Man and Biosphere Programme Young Scientist Awards for his project on the dispersal of invasive alien plants, 24 June 2010.

Foxcroft, L.C. 2010. Interview on SAfm discussing the invasion of *Lantana camara* into Kruger National Park, June 2010.

Jansen Van Vuuren, B. Interviewed for SAFM concerning genetic research appearing in *Journal of Wildlife Research*, 16 September 2010.

Lee, J. Interviewed for SAFM concerning Antarctic research, 14 January 2010.

McGeoch, M.A. Interviewed for 567 Cape Talk concerning research findings of the Global Invasive Species Programme, 18 August 2010.

McGeoch, M.A. Interviewed for 567 Cape Talk concerning research findings of the Global Invasive Species Programme, 28 January 2010.

McGeoch, M.A. Interviewed for FMR concerning research findings of the Global Invasive Species Programme, 10 May 2010.

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McGeoch, M.A. Interviewed for OFM concerning research findings of the Global Invasive Species Programme, 10 May 2010.

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McGeoch, M.A. Interviewed for Rippel 90.5FM concerning research findings of the Global Invasive Species Programme, 10 May 2010.

McGeoch, M.A. Interviewed for Spektrum on Radio Sonder Grense concerning research findings of the Global Invasive Species Programme, 01 February 2010.

Scott, D. Interviewed for Earth Science on SAFM, concerning the Antarctica Legacy Project, 23 September 2010.

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Scott, D. Interviewed for Spektrum on Radio Sonder Grense, concerning the Antarctica Legacy Project, 06 September 2010.

Scott, D. Interviewed for Spektrum, a programme on Radio Sonder Grense, concerning the Antarctica Legacy Project, 7 December 2010.

Scott, D. Interviewed for Talk Radio 702, concerning the Antarctica Legacy Project, 07 September 2010.

Van der Watt, L. Interviewed for Afternoon Talk on SAFM, concerning the Antarctica Legacy Project, 28 December 2010.

Van Wilgen, B.W. Interviewed on Cape Talk, concerning a career in ecology.

Van Wilgen, B.W. Interviews on M-Net's *Carte Blanche* programme, concerning fire experiments in the Kruger National Park.

Van Wilgen, N. Interviewed for 567 Cape Talk regarding her research on alien pet reptiles, 26 May 2010.

9 Stage progress

Progress according to Service Level Agreement No. 4 of 5 (2009-2011). 2010 was the second year of Stage 4.

Time frames:

The pending Gate review (Gate 4) shall take place during February or March 2012.
2010: n/a

Two CoE Advisory Board (virtual or real) meetings should take place per annum during this Stage, typically during March and October of each year.
2010: Board meetings took place on 16 March and 9 November

Activities related to the Current Stage:
The CoE shall provide to the NRF a list of students that are being supported by the Centre by end April of each year. Additional students can be appended to this list as and when they arrive.
2010: Student lists submitted on 3 May (provisional) and 17 September (final)

The CoE will publish 'nuggets' of information on its website and provide these at six-monthly intervals to the NRF.
2010: Nuggets submitted on 15 June 2010 and 24 August 2010

Financial responsibilities:
The CoE shall present an audited set of financial statements annually at the March Advisory Board meeting reflecting the financial situation of the CoE during the previous financial year.
2010: Audited statements to be presented to the Board in March 2011

The CoE shall submit monthly cash-flow statements within 15 days of the end of each calendar month according to the NRF template for cash flow reporting.
2010: Cash flow statements for January to December submitted on schedule

Reports due in this Stage:
The CoE shall submit an Annual Progress Report by no later than end March each year, including the Stage 4 Gate Review Documentation by no later than March 2012 to be reviewed by the CoE Advisory Board.
2010: Annual Report completed

The CoE shall submit a Statement of Compliance by no later than March 2012 referring to Stage 4.
2010: n/a

Standard Output Targets per annum in the Current Stage:
Total number of students supported ≥ ***50*** on average per annum
2010: 75 incl. post-docs

Woman students ≥ ***50***% of all students on average per annum
2010: 45 (60%)

Black students ≥ ***50***% of all students on average per annum
2010: 32 (43%)

Number of social science students ≥ ***2*** on average per annum

2010: 2

Average duration of submitted Masters degrees (post Honours) ≤ ***2.5*** years at end of stage
2010: 2.3 years

Average duration of submitted Ph.D. degrees (post Masters) ≤ ***3.5*** years at end of stage
2010: 4.6 years

Average duration of submitted Ph.D. degrees (upgraded from Masters) ≤ ***5*** years at end of stage
2010: 3.4 years

Post-doctoral researcher ≥ ***10***% of all students at end of stage
2010: 17% (13)

Each core team member must undertake at least one scientific review per annum on behalf of the NRF (postal peer review process or panel)
2010: 31

Number of patents ≥ ***0***
2010: none

Number of peer reviewed publications ≥ ***60*** on average per annum
2010: 93

Number of peer reviewed publications ≥ ***1*** with an impact rating of ≥ ***15*** on average per annum
2010: 2

Number of peer reviewed publications ≥ ***10*** with an impact rating of ≥ ***3.5*** on average per annum
2010: 26

Number of national conference presentations ≥ ***20*** on average per annum
2010: 27 (4 invited, plenary and keynote; 11 oral; 12 poster)

Number of international conference presentations ≥ ***10*** on average per annum
2010: 40 (3 invited, plenary and keynote; 31 oral; 6 poster)

Number of joint venture student training initiatives ≥ ***20*** on average per annum

2010: 46 (15 Academy students; 31 co-supervisions)

Number of local conferences organized ≥ ***1*** at end of stage
2010: 1 (WfW/EDRR course, October 2010)

Number of international conferences organized ≥ ***1*** at end of stage
2010: 1 (Acacia Workshop, October 2010)

Special Output Targets for the Current Stage:
At least one full CoE team activity per annum.
2010: Annual Research Meeting held on 18 and 19 November; all CTMs attended

Successful expansion of Iimbovane outreach project to additional schools in the WCED region.
2010: The project was successfully implemented in 18 new full participation schools and 10 new subscription schools.

10 Conclusion

The C·I·B continues to perform at a high level. The current stage is one in which the Centre is expected to act as a 'cash cow', meaning that it should be delivering many resources at a high level and should be adding substantial value to the DST-NRF investment. In all of its Key Performance Areas, the C·I·B is delivering value in excess of that which could be obtained from the current financial input from the DST-NRF. It is generating additional resources greater in total amount than the core grant, producing students at a rate that is more than commensurate with the inputs, and achieving at levels beyond those expected by the Board as set by the current Service Level Agreement. The only areas where performance is falling short of the targets is in black student engagement in the Centre's activities, and in the duration of Ph.D.s. The former trend was recognized early in 2010 (based on the 2009 assessment) and substantive steps to rectify the situation were taken. These are now having the requisite effects and the black student participation levels in 2011 have increased thanks to a rigorous recruitment process. As for Ph.D. student duration, it appears to be the consequence of an outlier, but a full audit of Core Team Member performance will be undertaken in 2011 and any problem areas identified. Once this has been done the supervisors and students that may be in need of assistance will be identified and appropriate action taken by the C·I·B science leadership with the assistance of the resources at Stellenbosch University.

11 Finances

Attached as PDF file

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS - 31 DECEMBER 2010

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2010

CONTENTS **Page**

The annual financial statements have been approved by the Board
and is signed on their behalf by:

.....

.....2011
DATE

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF FINANCIAL POSITION AT 31 DECEMBER 2010

	Notes	2010 R	2009 R
ASSETS			
NON-CURRENT ASSETS		933,736.85	1,152,263.76
Equipment and vehicles	2	933,736.85	1,152,263.76
CURRENT ASSETS		2,083,373.81	2,164,398.68
Trade and other receivables	3	107,535.85	652,488.95
Stellenbosch University	4	1,975,837.96	1,511,909.73
TOTAL ASSETS		**3,017,110.66**	**3,316,662.44**
EQUITY AND LIABILITIES			
CAPITAL AND RESERVES		2,658,572.77	3,000,500.05
Accumulated funds		2,658,572.77	3,000,500.05
CURRENT LIABILITIES		358,537.89	316,162.39
Trade and other payables	5	358,537.89	316,162.39
TOTAL FUNDS AND LIABILITIES		**3,017,110.66**	**3,316,662.44**

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER 2010

	Notes	2010 R	2009 R
Revenue		7,748,899.00	6,803,557.00
Other income		4,405,734.06	5,059,858.80
Operating expenses	7	(12,667,355.09)	(11,666,254.63)
Operating (loss)/profit		(512,722.03)	197,161.17
Finance income		171,071.88	203,581.11
Finance cost		(277.13)	(1,210.68)
(Loss)/surplus for the year		(341,927.28)	399,531.60
Other comprehensive income		-	-
Total comprehensive (loss)/income for the year		(341,927.28)	399,531.60

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 DECEMBER 2010

	2010 R	2009 R
ACCUMULATED FUNDS		
At the beginning of the year	3,000,500.05	2,600,968.45
Total comprehensive (loss)/income for the year	(341,927.28)	399,531.60
At the end of the year	**2,658,572.77**	**3,000,500.05**

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

	2010 R	2009 R
CASH FLOWS FROM OPERATING ACTIVITIES		
Net (loss)/surplus for the year	(341,927.28)	399,531.60
Adjustment for:		
Interest received	(171,071.88)	(203,581.11)
Interest paid	277.13	1,210.68
Exchange rate loss	428.02	6,963.36
Depreciation	455,437.71	414,876.38
Loss on sale of equipment and vehicles	-	2,468.78
Operating (loss)/profit before working capital adjustments	(56,856.30)	621,469.69
Working capital adjustments	586,900.58	(557,969.24)
Decrease/(increase) in trade and other receivables	544,953.10	(645,148.95)
Increase in trade and other payables	41,947.48	87,179.71
Cash generated from operations	530,044.28	63,500.45
Interest received	171,071.88	203,581.11
Interest paid	(277.13)	(1,210.68)
NET CASH FLOWS FROM OPERATING ACTIVITIES	700,839.03	265,870.88
CASH FLOWS FROM INVESTMENT ACTIVITIES		
Equipment and vehicles purchased	(236,910.80)	(335,249.66)
(Increase)/decrease in amount owed by Stellenbosch University	(463,928.23)	69,678.78
NET CASH FLOWS FROM INVESTMENT ACTIVITIES	(700,839.03)	(265,570.88)
NET INCREASE IN CASH AND CASH EQUIVALENTS	-	-
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	-	-
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	-	-

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2010

1. ACCOUNTING POLICY

The annual financial statements are prepared on the historical cost basis, with the exception of AC 133 where assets and liabilities are stated at fair value, in accordance with South African Statements of Generally Accepted Accounting Practice. The following are the principal accounting policies of the centre which are consistent in all material respects with those applied in the previous year.

EQUIPMENT AND VEHICLES

Equipment and vehicles are stated at historical cost and depreciation is calculated on the straight-line method to write off the cost of the assets to their residual values over their estimated useful lives as follows:

Laboratory equipment at 20% per year on the straight-line method;
Office equipment at 10% per year on the straight-line method;
Computers at 33.3% per year on the straight-line method;
Vehicles at 25% per year on the straight-line method, with a 40% residual value.

The assets' residual values and useful lives are reviewed, and adjusted if appropriate, at each balance sheet date.

IMPAIRMENT OF ASSETS

Equipment and vehicles are reviewed for impairment losses whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognised for the amount by which the carrying amount of the asset exceeds its recoverable amount, that is, the higher of an asset's selling price and value in use. For the purposes of assessing impairment, assets are grouped at the lowest level for which there are separately identifiable cash flows.

TRADE AND OTHER RECEIVABLES

Trade and other receivables originated by the centre are carried at the fair value and subsequently measured at amortised cost using the effective interest rate method, less provision for impairment. Fair value is the estimated future cash flows discounted at the effective interest rate. A provision for impairment is established where there is objective evidence that the centre will not be able to collect all amounts due according to the original terms of the transaction. The amount of the provision is the difference between the carrying amount and the recoverable amount, being the present value of expected cash flows, discounted at the market rate of interest for similar borrowers.

TRADE AND OTHER PAYABLES

Trade and other payables are carried at the fair value of the consideration to be paid in future for goods or services that have been received or supplied and invoiced or formally agreed with the supplier.

FINANCIAL INSTRUMENTS

Financial instruments on the statement of financial position include trade and other receivables, trade and other payables and a loan to Stellenbosch University. These instruments are generally shown at their estimated fair value.

Financial instruments are initially recognised when the centre becomes a party to the contractual terms of the instruments and are measured at cost, including transaction cost, which is the fair value of the consideration given (financial assets) or received (financial liabilities). Subsequent to initial recognition, these instruments are measured as set out in the applicable accounting policies.

Financial assets (or a portion thereof) are de-recognised when the centre realises the rights to the benefits specified in the contract, the rights expire or the centre surrenders or otherwise loses control of the contractual rights that comprise the financial asset.

On de-recognition, the difference between the carrying amount of the financial asset and the proceeds receivable and any prior adjustments to reflect fair value that had been recognised in equity are included in the income statement.

Financial liabilities (or a portion thereof) are de-recognised when the obligation specified in the contract is discharged, cancelled or expired. On de-recognition, the difference between the carrying amount of the financial liability, including related unamortised costs and amounts paid for it are included in the income statement.

The carrying amounts of financial assets and liabilities with maturity of less than one year are assumed to approximate their fair value.

1. ACCOUNTING POLICY (continued)

INCOME RECOGNITION

Income consists mainly of a National Research Foundation grant, the contribution from the Vice-chancellor: Research to the centre and income received for work performed on sundry projects.

Income from the National Research Foundation and the Vice-chancellor: Research is recognised when it is received. Other income is recognised as it accrues.

Interest income is recognised as it accrues (taking into account the effective return on assets) unless collectability is in doubt.

FOREIGN CURRENCY TRANSLATION

(a) Functional and presentation currency

Items included in the annual financial statements are measured using the currency of the primary economic environment in which the centre operates ('the functional currency'). The annual financial statements are presented in South African Rand ("R"), which is the centre's functional and presentation currency.

(b) Transactions and balances

Foreign currency transactions are translated into the functional currency using the exchange rates prevailing at the dates of the transactions. Foreign exchange gains and losses resulting from the settlement of such transactions and from the translation at year-end exchange rates of monetary assets and liabilities denominated in foreign currencies are recognised in the income statement.

STANDARDS, INTERPRETATIONS AND AMENDMENTS NOT YET EFFECTIVE

The following standards and amendments to existing standards have been published and are mandatory for the centre's accounting periods beginning on or after 1 January 2011 or later periods, but which the centre has not early adopted.

Management is of the opinion that these amendments will not have a material effect on the financial statements.

AC 146: Financial Instruments (Effective 1 January 2013)
Amendment to AC125: Classification of Rights Issues (Effective 1 February 2010)
AC 452: Extinguishing Financial Liabilities with Equity (Effective 1 July 2010)
Amendments to AC 126: Related Party Disclosures (Effective 1 January 2011)
Amendments to AC 447: Prepayments of a Minimum Funding Requirements (Effective 1 January 2011)
Revision to AC 504: AC 116 - The limit on a defined benefit asset, Minimum funding requirements and their interaction in the South African pension fund environment (Effective 1 January 2011)
Amendment to AC 146: Financial Instruments - Disclosure (Effective 1 July 2011)
Amendments to AC 102: Deferred Tax - Recovery of Underlying Assets (Effective 1 January 2012)

There are numerous other new standards or amendments to existing standards as part of the International Accounting Standards Board's improvement projects that are not yet effective for the centre. Each of these has been assessed and will not have a material impact on the financial statements.

CRITICAL ACCOUNTING ESTIMATES AND JUDGEMENTS

Estimates and judgements are continually evaluated and are based on historical experience and other factors, including expectations of future events that are believed to be reasonable under the circumstances.

Useful lives of assets

The useful lives of assets is estimated based on past experience and the characteristics of the specific items.

There were no critical judgements in applying the centre's accounting policies.

2. EQUIPMENT AND VEHICLES

	Equipment R	Vehicles R	TOTAL R
31 December 2010			
Carrying amount at the beginning of the year	726,517.93	425,745.83	1,152,263.76
Cost	2,103,268.82	371,822.10	2,475,090.92
Accumulated depreciation	(1,376,750.89)	53,923.73	(1,322,827.16)
Additions during the year	236,910.80	-	236,910.80
Disposals	-	-	-
Cost	(9,511.58)	-	(9,511.58)
Accumulated depreciation	9,511.58	-	9,511.58
Depreciation for the year	(381,073.29)	(74,364.42)	(455,437.71)
Carrying amount at the end of the year	582,355.44	351,381.41	933,736.85
Cost	2,330,668.04	371,822.10	2,702,490.14
Accumulated depreciation	(1,748,312.60)	(20,440.69)	(1,768,753.29)
31 December 2009			
Carrying amount at the beginning of the year	808,313.43	425,745.83	1,234,059.26
Cost	1,774,271.96	371,822.10	2,146,094.06
Accumulated depreciation	(965,958.53)	53,923.73	(912,034.80)
Additions during the year	335,249.66	-	335,249.66
Disposals	(2,168.78)	-	(2,168.78)
Cost	(6,252.80)	-	(6,252.80)
Accumulated depreciation	4,084.02	-	4,084.02
Depreciation for the year	(414,876.38)	-	(414,876.38)
Carrying amount at the end of the year	726,517.93	425,745.83	1,152,263.76
Cost	2,103,268.82	371,822.10	2,475,090.92
Accumulated depreciation	(1,376,750.89)	53,923.73	(1,322,827.16)

3. TRADE AND OTHER RECEIVABLES

	2010 R	2009 R
Trade receivables	40,236.20	626,208.64
Prepaid expenses	65,000.00	-
Other	2,299.65	26,280.31
	107,535.85	652,488.95
The ageing of these receivables are as follows:		
Up to 2 months	-	626,208.64
2 to 6 months	40,236.20	-
	40,236.20	626,208.64

4. STELLENBOSCH UNIVERSITY

The loan to Stellenbosch University is not secured and is subject to interest rates linked to prime. The rate at 31 December 2010 was 7.00% (2009: 8.50%). The loan has no fixed terms of repayment.

	2010 R	2009 R
5. TRADE AND OTHER PAYABLES		
Leave pay provision	274,919.92	267,329.15
Other creditors	37,789.97	10,210.04
Provision for audit fees	45,828.00	38,623.20
	358,537.89	316,162.39

6. INCOME TAX

The centre is exempt from income tax in terms of article 10(1)(cA)(i) of the Income Tax Act.

7. OPERATING EXPENSES

Operating expenses includes the following disclosable amounts:

Audit fees - audit	45,828.00	38,623.20
- previous year underprovision	3,798.60	4,312.00
Depreciation	455,437.71	414,876.38
Foreign exchange loss	428.02	6,963.36
Loss on sale of equipment and vehicles	-	2,468.78
Salaries	4,353,142.55	4,129,686.28

8. FINANCIAL INSTRUMENTS

Foreign currency management and exposure

The centre is exposed to exchange rate fluctuations. Payments are evaluated on an individual basis with assistance from the bank to decide whether options should be used as forward cover. No forward exchange contracts exist at year end.

Liquidity risk

Liquidity is managed by monitoring forecast cash flows.

Credit risk management

Financial assets that can potentially subject the centre to credit risk consist of trade and other receivables. Even though the centre has debtors, it is not deemed to be a risk. The reason is that collectability has never been a problem in the past. The financial condition of these clients in relation to their credit standing is evaluated on an ongoing basis. The carrying values of the financial assets represent the maximum exposure to credit risk.

Cash flow and fair value interest rate risk

As at 31 December 2010 and 2009, if the interest rate had been 100 basis points higher/lower and all other variables held constant, the centre's (loss)/profit would have decreased/increased as a result of interest received on loans by R19 758.38 (2009: R15 119.10). The other financial instruments are not exposed to interest rate risk.

8. FINANCIAL INSTRUMENTS (continued)

Fair values

At 31 December 2010 and 2009 the carrying amounts of receivables, loans and payables approximated their fair values due to the short-term maturities of these assets and liabilities.

	Carrying value	Contractual cash flows	< 1 year	1 - 5 years	> 5 years
	R	R	R	R	R
Financial liabilities					
31 December 2010					
Trade and other payables	358,537.89	358,537.89	358,537.89	-	-
Net financial liabilities	358,537.89	358,537.89	358,537.89	-	-
31 December 2009					
Trade and other payables	316,162.39	316,162.39	316,162.39	-	-
Net financial liabilities	316,162.39	316,162.39	316,162.39	-	-

Capital risk management

The centre manages its capital to ensure that it will be able to continue as a going concern while maximising the return to stakeholders through the optimisation of the debt and equity balance. The capital structure of the centre consists of reserves as disclosed in the statement of changes in equity. The directors review the capital structure on an annual basis. As part of this review, they consider the centre's commitments, availability of funding and the risks associated with each class of capital. The centre's overall strategy remains unchanged from the prior year.

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

DETAIL INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2010

	2010 R	2009 R
INCOME	12,325,704.94	12,066,996.91
Interest received	171,071.88	203,581.11
National Research Foundation grant	7,748,899.00	6,803,557.00
Other income	4,405,734.06	5,059,858.80
EXPENDITURE	12,667,632.22	11,667,465.31
Operational expenses	8,314,489.67	7,537,779.03
Advertisements	28,738.91	212,641.66
Audit fees - current year	45,828.00	38,623.20
- previous year underprovision	3,798.60	4,312.00
Consumables	90,424.94	50,610.19
Consultation	4,311.72	-
Copying and stationery	51,844.43	89,452.99
Depreciation	455,437.71	414,876.38
Entertainment	2,290.64	39,152.23
Foreign exchange loss	428.02	6,963.36
Interest paid	277.13	1,210.68
Insurance	4,575.00	3,600.00
Levies	186,533.62	222,106.97
Loss on sale of equipment and vehicles	-	2,468.78
Membership and affiliation fees	30,399.47	29,777.14
Non-capitalised books	-	3,156.70
Small capital works: not capitalised	29,620.15	94,132.50
Postage, telephone and fax	72,565.87	83,986.75
Safety clothing	5,992.76	325.00
Research costs	350.00	-
Rent paid for facilities	4,800.00	412.19
Repairs	9,574.37	13,177.30
Software and internet	31,569.55	19,031.28
Sundry expenses	17,497.08	34,652.14
Team member research costs	6,483,406.15	5,735,663.13
Transport and accommodation	632,529.34	426,046.46
Workshops	121,696.21	11,400.00
Personnel expenses	4,353,142.55	4,129,686.28
Salaries	4,353,142.55	4,129,686.28
(LOSS)/SURPLUS FOR THE YEAR	(341,927.28)	399,531.60