DST-NRF Centre of Excellence for Invasion Biology

ANNUAL PROGRESS REPORT

Reporting period:
1 January to
31 December 2009

Faculty of Science, Room 2039, Natural Sciences Building, Merriman Avenue, Stellenbosch, South Africa

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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: 08 March 2010
	:	Financials: 25 March 2010

Summary of progress against 5 KPAs. (Please limit your responses to completed tasks or work in progress and exclude plans for the future.)

(i) Research

The C·I·B is now performing at an exceptionally high level in terms of its research. Over the past year, more than 90 research papers were published in the primary literature, with contributions both to the top general journals and the top ecological journals. All of the major long-term and short-term objectives identified in the strategic plan current for this period are being addressed, with research including a wide range of topics covering all of the major disciplines represented by the Centre. Indeed, the C·I·B has been credited, by its peers, as an outstanding research entity within South Africa that maintains an exceptionally high standard as an international player.

(ii) Education and Training

Student training continues to remain in the vanguard of the Centre's activities. Seventeen students who had been supported by the C·I·B in 2009 or earlier years completed their degrees, representing seven honours/4 year B. degree, eight masters, and two Ph.D. degrees. The Biodiversity Conservation Academy continues to attract excellent students from across the country and has now been extended to include interns from the South African National Biodiversity Institute. This year, 14 participants from six higher education institutions and

SANBI attended the academy, of which nine were from historically disadvantaged backgrounds.

(iii) Information Brokerage

The Iimbovane project continues to excel. In 2009 it was expanded to five additional schools in its full participation mode, resulting in 18 schools across the Western Cape Province now participating fully in the project. In addition, the Iimbovane subscription system has been implemented, resulting in another ten schools participating, in a reduced manner, in the project. Much of the expansion has been funded by the Rand Merchant Bank Fund and the Anglo American Chairman's fund. In addition to this, the C·I·B's main outreach activity, the Centre has featured in an exceptionally wide range of print and other media owing both to its research activities and to the many exceptional achievements of its members over the 2009 period. The D-SPACE system used by the C·I·B for data submission and retrieval continued to function effectively. Over the 2009 year, thirty seven theses and datasets were submitted to the system, as well as 77 long-term datasets originating from the C·I·B's long term monitoring transects. Two hundred and sixty five publications were also lodged in the system.

(iv) Networking

Existing agreements with a range of institutions and entities were maintained or renewed and several new associations were developed, especially via the Research Associates route (specifically Dr. Mark Robertson, University of Pretoria, and Mr. John Cooper, University of Cape Town/private consultant). A new Memorandum of Understanding was entered into with the Applied Biodiversity Research Division of SANBI, which resulted in the appointment of a joint SANBI/C·I·B Invasive Species Scientist, Dr. John Wilson, based at the C·I·B hub in Stellenbosch. The Working for Water Memorandum of Agreement was expanded to include new work on restoration following the removal of *Eucalyptus* species. Centre members continue to work both with each other and with a wide range of colleagues from national institutions and from abroad.

(v) Service rendering

The C·I·B continues to deliver services to a wide range of partners and clients. It participated in the development of an invasive species strategy for the Western Cape (published by C.A.P.E.), and, through the offices of Prof. D.M. Richardson, hosted the 10th international conference in the Ecology and Management of Plant Invasions (EMAPI). Centre members undertook a wide range of reviewing and/or contractual tasks for funding agencies, journals, employing institutions, and international bodies.

What was the gender impact of your work?

Gender equity continues to form a major theme underlying the C·I·B's activities with women constituting 58% of the personnel/students associated with the centre and 83% of the

Stellenbosch hub staff. The C·I·B's outreach work and long-term projects are run by women, who are, without exception, remarkable role models showing what can be achieved by women in science.

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

The C·I·B now has an exceptionally competent staff complement. Whilst the conditions of service at Stellenbosch University are typically good, the quality of C·I·B staff make them exceptionally attractive in the market place. Substantial concern exists that staff will be attracted away from the Centre, especially if uncertainty about the Centre's future support from and association with the DST-NRF continues.

A growth trajectory that would see an increase in the size of the C·I·B to much larger than about an additional 30%, would mean a substantial re-organization of the Centre's business model. Whilst not a 'red flag' *per se*, this threshold effect must be borne in mind because it would mean a change in the way the Centre's business would operate, especially in terms of the expectations placed on the Centre's Director and Deputy Directors. For example, a further doubling in the extent of the Centre's business would mean that management, administration and fund raising would occupy the core management full time, with little opportunity for research. Such substantive growth implies that the core management would either have to downscale their research activities, or seek a new set of business managers for the C·I·B. This kind of change might well compromise the reputation of the C·I·B for science excellence.

General Comments

The C·I·B continues to show exceptional performance across all of its key areas of activity, and is now 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, 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

1.1 Objectives

The C·I·B's research is concerned 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 advice.

A spectrum of scientific approaches is supported, ranging from investigator-driven to the themed modes; from the theoretical to the empirical; and from the non-instrumental to the instrumental. The overarching goals 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 new developments 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 Overarching Strategic Plan in support of the Millennium Development Goals (http://www.sun.ac.za/osp_english/).

Much of this work is still in progress, and in keeping with our reporting policy, will be reported once published.

1.2 Progress

2009 was another productive year for the C·I·B in terms of publications, with 92 papers in peer-reviewed journals and seven chapters in edited books. The list of publications indicates that research undertaken by the C·I·B spans a formidable range of topics, speciality areas, taxa and geographical regions. Some of the work is theoretical, such as that on fundamental aspects of spatial ecology. At the other end of the spectrum, many published papers attest to the strong focus on applied and practical issues. This summary provides an overview of some of the exciting and important research results to emerge from C·I·B-funded work that was *published* in 2009. The report is by no means comprehensive. Further details on work undertaken by the different groups in the C·I·B can be found on the web site, and by following the links to the online resources for many research products (see Sections 8.1 to 8.4).

1.2.1 Long term collaborative research

A. Long-term change in insect assemblages

Body size and functional traits in ants

A major drive was initiated to understand change in body size and functioning in ant assemblages across the long-term sites in the Cederberg and Iimbovane transects. Almost the whole Chown laboratory, plus René Gaigher from Michael Samways' group, were involved in the work. The aim is to screen all the species from the transects for size variation, and variation in four key ecophysiological traits. So far, body size data have been collected from 2245 individuals from 45 species and data on critical thermal minima and maxima have been collected for more than 40 species. The work is ongoing and will continue for some time. One of the major aims of the project is to determine effect and response functional traits that play a role during invasion by the Argentine ant and through a pronounced El Niño Southern Oscillation (ENSO) event. A further aim is to provide a community phylogenetics approach for an entire set of montane assemblages by barcoding the species involved (using mtDNA COI). Support for this work will be sought in 2010.

B. Long-term changes to the Prince Edward Islands ecosystem

***Azorella selago* as an ecosystem engineer on Marion Island**

By interacting with and changing their immediate surroundings, plants (especially pioneer species) play an important role in landscape evolution in severe environments. On sub-Antarctic Marion Island an important interaction exists between the geomorphology of fellfield landscapes and the dominant vascular plant species, *Azorella selago*. For example, by colonising loose and exposed substrates, these cushion plants affect slope stability and improve substrate nutrient and moisture status. *Azorella selago* cushions are also considered to influence frost creep and other sediment movement processes and play an important role in the formation of terraces and lobes.

To improve understanding of the two-way interactions of *A. selago* plants and substrate movement and sorting, C·I·B associate Natalie Haussmann quantified the directionality in grain size distribution of sediment surrounding *A. selago* cushions of varying size and shape, using image analyses. The results (Haussmann *et al.* 2009; *Geomorph.* **107**, 139-148) suggest that as cushions become larger they become more elongated, confirming general field observations. For all three sites examined, particles on downslope cushion sides were smaller than those of upslope cushion sides. Cushions also tend to grow more perpendicular to the slope as they become larger. As cushion growth commences, interactions with the surrounding sediment lead to sediment partitioning and terrace formation, a consequence of a combination of frost-related sediment transport and *A. selago* cushions acting as sediment obstructions. These results support the hypothesis that *A. selago* banked terrace development is a self-organising system where interactions between *A. selago* cushions and sediment movement provide important feedbacks resulting in spatially organised landscape patterns. Furthermore, results indicating the role of vegetation in sediment redistribution across diurnal

soil frost environments from this study are consistent with those from other maritime mid-latitude islands and those from high-altitude tropical mountains.

Natalie Haussmann's research has also examined the fine-scale spatial variability in frost dynamics (freeze-thaw frequency, duration and depth and related vertical frost heave) and erosion around crescent-shaped and round *A. selago* cushions, growing on slopes and flat terrain. The study specifically tested differences in frost dynamics and erosion between north and south cushion sides, windward and leeward cushion sides, up and downslope cushion sides and far from vs. closer to the cushion. Soil thermal and moisture patterns did indeed show spatial variation around cushions of *A. selago* as expected. This variability is probably the combined result of i) snow accumulation on leeward cushion sides, inducing insulation and cooling, and ii) drying on windward cushion sides. The very effective frost heave, often induced at temperatures above -2°C (previously thought to be the upper temperature at which frost heave occurred), predominantly resulted in complete heave of the erosion pins used at the site. This is a clear demonstration of the extensive frost heave in the area and its likely significance for biological processes (such as seedling mortality). As a result, no expected directional differences in frost heave could be demonstrated around cushions and therefore no evidence was found to suggest that frost heave is responsible for directional turf exfoliation and crescent cushion formation. Similarly, erosion rates showed no directionality around cushions. Further attention must be given to the consequences of this demonstrated microclimatic variation in assessing the role of *Azorella selago* as an ecosystem engineer in sub-Antarctic fellfield habitats.

The big chill – exploring impacts on springtail population dynamics

One of the major forecasts for long-term change at the Prince Edward Islands and elsewhere in the Antarctic region is an increase in the frequency and intensity of freeze-thaw events. These events interact with the lower lethal temperature of many species to determine population responses. Recent work on Marion Island has sought to determine the likely outcome thereof for indigenous and invasive springtails, adopting a relatively uncommon, though significant, assemblage approach. It is widely held both in the physiological literature, and more generally, that the average characteristics of species within an assemblage differ among sites. Such generalizations should be based on investigations of whole assemblages at sites, but this is rarely done. Such a study was undertaken for virtually the full assemblage of springtails found at sub-Antarctic Marion Island by investigating supercooling points (SCPs) of 12 of the 16 species that occur there. Assemblage level variation tends to be less than that documented for assemblages across northern hemisphere sites but similar to that found at some Antarctic locations. Across this set of species, the mean SCPs of the indigenous species (mean ± SE −17.2 ± 0.4 °C) did not differ significantly from that of the invasive species (−16.3 ± 0.7 °C). Overall, the introduction of several species to the island does not appear to have led to functional homogenization (for this trait). By combining the assemblage-level SCP data with information on the abundances of the species in each of four major habitats, it was shown that severe but uncommon low temperature events could substantially alter species

relative abundances. By resetting assemblage trajectories, such events could play an important role in the terrestrial system at the island, especially if such events become more frequent and severe with changing climates (Janion et al. 2009; *Physiol. Entomol.* **34**, 284-291.).

1.2.2 Highlights of short-term work

A. Biodiversity foundations

Spatial patterns in the natural world

Understanding patterns ranging from a cloud of atoms to the distribution of species across scales is one of the central problems of science. In physics, Bose-Einstein condensation describes how numerous atoms are distributed in lattices with changing sizes. In ecology, alpha and beta diversity measures often reveal the scale sensitivity of species richness. The species-area relationship and the scaling pattern of species distribution (measured by occupancy or occurrence) have attracted much attention from ecologists. In the analysis of those patterns across scales (called scaling patterns), a severe statistical problem emerges, namely the Modifiable Areal Unit Problem (MAUP; Hui, 2009; *Foundations of Computational Intelligence Volume 2: Approximate Reasoning*. A.E. Hassanien *et al.* eds. pp. 175-196, Springer, Berlin). The MAUP prevails in the analysis of spatially aggregated data and influences pattern recognition. It describes the sensitivity of the measurement of spatial phenomena to the size (the scale problem) and the shape (the aggregation problem) of the mapping unit. This problem has received much attention from fields as diverse as statistical physics, image processing, human geography, landscape ecology, and biodiversity conservation.

Recently in the field of spatial ecology a Bayesian estimation model (BEM) was proposed by C·I·B researchers to explain how descriptions of species distribution changes with grain size and shape. The BEM is obtained from the comparison of pair approximation (in the spatial analysis of cellular automata) and join-count statistics (in the spatial autocorrelation analysis), and has potential for estimating abundance using the scaling pattern of occupancy. Because abundance is one of the most important measures of species conservation status and can be used as a surrogate for species' ecological functioning, a diversity of techniques, including mark–recapture methods, has been used to estimate species abundance. However, these techniques require fine-scale data that are often not available. As a result, a cost-efficient technique that can be applied at broad spatial scales (e.g. the continental level) and for whole communities is urgently needed. Recent progress in macroecology, and in particular the mechanisms underlying the occupancy–abundance relationship and the scaling pattern of occupancy, has provided such potential techniques. Using a dipswitch test with 15 criteria, Hui *et al.* (2009; *Ecol. Appl.* **19**, 2038-2048) examined the ability of eight models of this kind, including the BEM, to estimate the abundance of 610 southern African bird species. The BEM produced the most reliable abundance estimates, and is therefore recommended for assemblage-scale regional abundance estimation. This model estimates a total of $\sim 2\times10^9$ birds in southern Africa (South Africa, Lesotho, and Swaziland).

Species are not independent; they are associated positively or negatively (also known as spatial dissociation) with each other, as a result of, for instance, competition or facilitation in communities. Species association measures the degree of co-occurrence and co-distribution of two species in samples. The scaling pattern of species association is closely tied to patterns of beta diversity and the species-area relationship, and plays a vital role in identifying species assembly patterns. The scaling pattern of occupancy, spatial autocorrelation and species association provide a comprehensive description of species distribution in ecological communities. Based on the Bayesian rule and join-count statistics, Hui (2009; *J. Theoret. Biol.* **261**, 481-487) presented a mathematical model that can demonstrate the effect of spatial scale on the observation of species distribution and association. Results showed that the intensity of species association declines when the grain in the spatial analysis increases, although the category of species association (positive or negative) remains the same. Species independence was shown to be scale-free. Regardless of the possible patterns of species association, species tend to be independent from each other when scaling-up, reflecting a percolation process. The model thus grasps the statistical essence of species scaling pattern and presents a step forward for unveiling mechanisms underlying macroecological patterns.

Conceptual foundations for macrophysiology expanded

Widespread recognition of the importance of biological studies at large spatial and temporal scales, particularly in the face of many of the most pressing issues facing humanity, has fuelled the argument that there is a need to reinvigorate such studies in physiological ecology through the establishment of macrophysiology. Following a period when the fields of ecology and physiological ecology had been regarded as largely synonymous, studies of this kind were relatively commonplace in the first half of the twentieth century. However, such large-scale work subsequently became rather scarce as physiological studies concentrated on the biochemical and molecular mechanisms underlying the capacities and tolerances of species. In some sense, macrophysiology is thus an attempt at a conceptual reunification. A multi-author contribution, involving several C·I·B-affiliated researchers, developed a conceptual framework for the continued development of macrophysiology (Gaston *et al.* 2009; *Am. Nat.* **174**, 595-612). They subdivided this framework into three major components: the establishment of macrophysiological patterns, determining the form of those patterns (the very general ways in which they are shaped), and understanding the mechanisms that give rise to them. The r x c matrix approach was used as a basis for understanding the patterns, so expanding on previous work.

Empirical evidence for spatial autocorrelation revisited

Steven Chown was involved with two studies which examined the empirical evidence for spatial autocorrelation and the efficacy of measures to correct for it. The first study (Warren *et al.* 2009; *Ecoscience* **16**, 95-110) investigated the efficacy of spatial pattern analysis for detecting pattern in empirical data at a fine scale using a field-based mesocosm experiment of a Drosophilidae community associated with decaying fruit. The mesocosm comprised two

microclimate treatments that generated a particular, expected spatial pattern in abundance and species richness. The magnitude of Moran's autocorrelation coefficients (I) were <0.3 (i.e. low). However, the detected pattern was unaffected. Low Moran's I values did not result from small sample sizes, neither was the significance of Moran's I falsely inflated by large sample sizes. Examination of published I values revealed that autocorrelation values between 0.1-0.3 are common in empirical data, particularly at fine (lag distance ≤ 1 m) spatial scales. Pooling temporal samples strengthened the detected output without affecting the form of spatial pattern. The authors concluded that 'weak' responses provide a valuable basis for mechanistic hypothesis generation, especially at fine spatial scales, and that the strength of spatial structure is likely to be determined by the spatial scale of the study.

The second study (Bini *et al.* 2009; *Ecography* **32**, 193-204) was an investigation of the relationship between environmental predictors and the geographical distribution of species richness, body size, range size and abundance in 97 multi-factorial data sets. The goal was to compare standardized partial regression coefficients of non-spatial ordinary least squares regressions (i.e. models fitted using ordinary least squares without taking autocorrelation into account; "OLS models" hereafter) and eight spatial methods to evaluate the frequency of coefficient shifts and identify characteristics of data that might predict when shifts are likely. Three metrics of coefficient shifts and eight characteristics of the data sets were generated as predictors of shifts. Typical of ecological data, spatial autocorrelation in the residuals of OLS models was found in most data sets. The spatial models varied in the extent to which they minimized residual spatial autocorrelation. Patterns of coefficient shifts also varied among methods and datasets, although the magnitudes of shifts tended to be small in all cases. The authors were unable to identify strong predictors of shifts, including the levels of autocorrelation in either explanatory variables or model residuals. Thus, changes in coefficients between spatial and non-spatial methods depend on the method used and are largely idiosyncratic, making it difficult to predict when or why shifts occur. The conclusion was that the ecological importance of regression coefficients cannot be evaluated with confidence irrespective of whether spatially explicit modelling is used or not. Researchers may have little choice but to be more explicit about the uncertainty of models and more cautious in their interpretation.

B. Biodiversity dynamics through space and time

There are maps and then there are maps – towards optimum efficiency of mapping of invasive species

Maps are used to illustrate the distribution of species. The way that the distribution of species is mapped has huge implications for understanding the ecology of the species. For invasive species, maps are often used to plan control operations, to prioritise species and areas for management intervention, and in attempts to understand the processes that generate distribution patterns. Not nearly enough attention is given to fundamental issues, such as the precision and accuracy at which species are mapped, the extent to which scaling up or down

affects our understanding of range dynamics of invasive species, and how we should map species in the future to make results useful for as many purposes as possible.

South Africa's Kruger National Park (KNP) provides a unique opportunity to explore the links between distribution pattern and spatial scale for invasive alien plants. KNP (c. 20 000 km^2 in extent) is one of the largest protected areas in the world that is actively managed for biodiversity conservation, and for which very detailed data on the distribution of invasive alien plants is available (spatially-explicit data comprising nearly 27 000 records with excellent coverage across the whole park). C·I·B Research Associate Llewellyn Foxcroft, core team member Dave Richardson and others have been working on this unique data set to address a wide range of questions related to the distribution of invasive species and requirements for mapping to inform management.

They showed that when assessing alien plant patterns, almost identical results are obtained when working at scales of quarter-degree grids and quaternary watersheds (the fourth level category in South Africa's river basin classification system), although watersheds are more ecologically meaningful. Likewise, insights gained from working at resolutions of 0.1-0.5 km and 1-5 km are similar. The data reveal that at a scale of 0.1 x 0.1 km cells, only 0.4% of KNP is shown as 'invaded', whereas over 90% of the park is 'invaded' when the data are interrogated at a resolution of quarter-degree cells. Selecting the appropriate scale of resolution is crucial when evaluating the distribution and abundance of alien plant invasions, understanding ecological processes, and operationalizing management applications and monitoring strategies (Fig. 1).

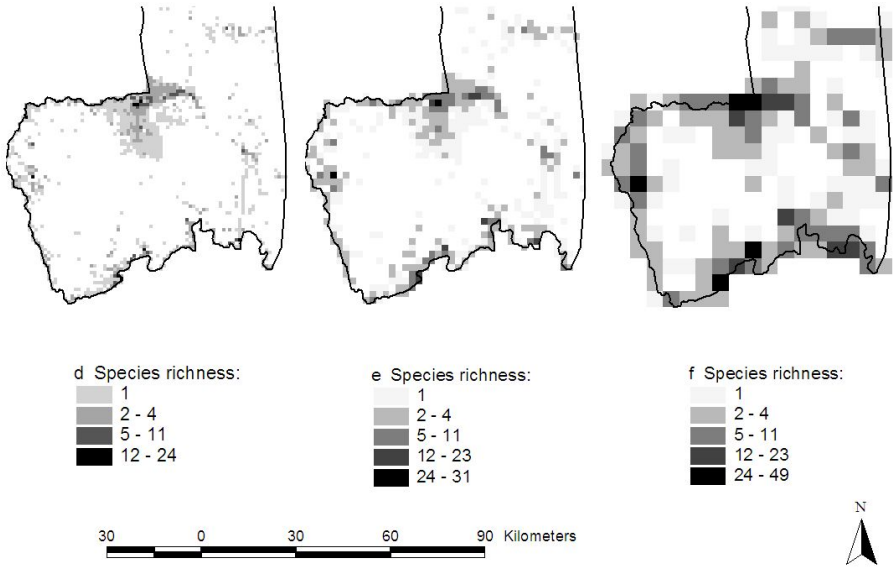

Figure 1. Alien plant richness data for the southern Kruger National Park, **d**. 1 x 1 km scale, **e**. 2 x 2 km scale, and **f**. 5 x 5 km scale (Reproduced from Foxcroft *et al*. 2009; *Diversity Distrib*. **13**, 367-378).

Quarter-degree grid cells and quaternary watersheds are most useful at a regional or national scale. Grid cells of 1 to 25 km^2 are generally useful for establishing priorities for and planning management interventions. Fine-scale data are useful for informing management in areas which are small in extent; they also provide the detail appropriate for assessing patterns and rates of invasion (Foxcroft *et al.* 2009; *Diversity Distrib.* **13**, 367-378). These results will be useful for guiding the establishment of standardize mapping protocols for invasive plants in protected areas in South Africa and around the world.

Flowering phenology – new insights on the recipes for success for plant invaders in Mediterranean-type ecosystems

Despite considerable progress in plant invasion ecology in recent years, much more still needs to be known about how species 'fit in' in the ecosystems they invade, and how they might adapt to the prevailing environmental conditions which may be very different in certain respects from those in their native habitats. 'Phenology' is the study of periodic plant and animal life cycle events and how these are influenced by seasonal and interannual variations in climate. For plants, one of the most interesting and important life cycle events is flowering. The timing of flowering is hugely important for a plant, and can affect the success of alien species, since it has an important influence on fecundity (the ability to reproduce).

Core team member Dave Richardson worked with a team of Spanish researchers from the Universidad de Alcala to examine patterns of flowering for invasive alien plant species and related natives in three regions with mediterranean-type climate: California, Spain and South Africa's Cape region. They studied 227 invasive-native pairs of plant species. A key finding of the research (Godoy *et al.* 2009; *Ann. Bot.* **103**, 485-494) was that invasive alien plant species have different patterns of flowering phenology to native species in the three regions. Whether the alien species flower earlier, later, or at the same time as natives depends on the climatic regime in the native range of the aliens and the proportion of species in the invasive floras originating from different regions. Species that were invasive in at least two of the regions had the same flowering pattern, showing that flowering phenology is a conservative trait. Invasive species with native ranges in temperate climates flower earlier than natives, those from mediterranean-type climates at the same time, and species from tropical climates flower later. In California, where the proportion of invaders from the Mediterranean Basin is high, the flowering pattern did not differ between invasive and native species, whereas in Spain the high proportion of tropical species results in a later flowering than natives and in the Cape region earlier flowering than natives was the result of a high proportion of temperate invaders. The authors concluded that observed patterns are due to the human-induced sympatry of species with different evolutionary histories whose flowering phenology evolved under different climatic regimes. The severity of the main abiotic filters imposed by the invaded regions (e.g. summer drought) has not been strong enough (yet) to shift the flowering pattern of invasive species to correspond with that of native relatives. It does, however, determine the length of the flowering season and the type of habitat invaded by summer-flowering aliens. Results suggest different implications for impacts at evolutionary time scales among the three regions.

Effects of climate change on bird distribution examined

Based on projected range changes (Fig. 3), C·I·B student Bernard Coetzee, core team member Berndt van Rensburg and co-workers showed that the South African Important Bird Area (IBA) network is likely to become less effective for conserving endemic birds under climate change. That is, 41% of the IBAs lose species, and 77% of the IBAs show rates of species turnover of more than 50%. Their irreplaceability analysis identified key refugia for endemic species under climate change; most of these highly irreplaceable regions are highly localised meaning that the endemic species analysed here experience similar range contractions to maintain climate niches, and many of these areas are not currently IBAs. In addition, many of the high priority areas that are IBAs fall outside of the current formal protected areas network (Coetzee *et al.* 2009; *Global Ecol. Biogeogr.* **18**, 701-710).

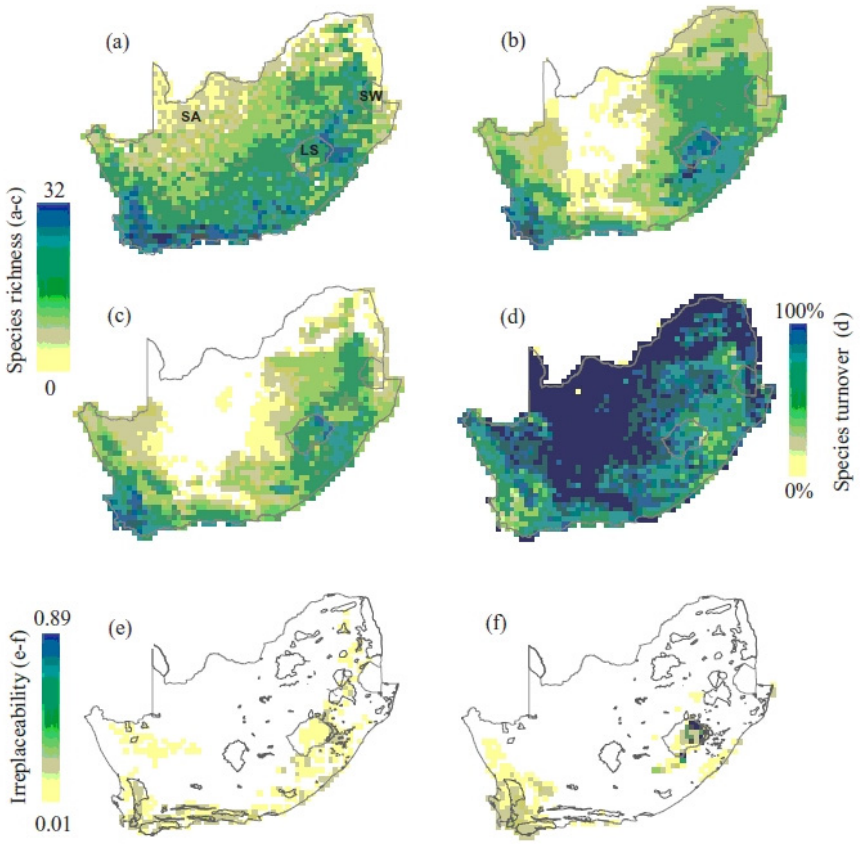

Figure 3. **a**. Current species richness of the 50 bird endemic species assessed. **b**. Modelled future bird species richness based on a consensus forecast created from 16 models and four climate change models for the period 2070–2100 under a full dispersal assumption. **c**. Modelled future bird species richness based on an identical consensus forecast constrained by a no-dispersal assumption, meaning that species will only occupy areas that are both currently suitable and predicted to be suitable in future. **d**. Bird species turnover per grid cell. **e**. Current irreplaceability patterns for 50 endemic bird species (Important Bird Area locations are in black). **f**. Future irreplaceability patterns based on a consensus forecast under a full dispersal assumption. South Africa (SA), Lesotho (LS) and Swaziland (SW) are indicated in grey. White squares indicate the absence of all species analysed (Reproduced from Coetzee *et al*. 2009; *Global Ecol. Biogeogr.* **18**, 701-710).

The importance of ecotones

Berndt van Rensburg and his team at the C·I·B's northern hub in Pretoria examined the hypothesis that areas of transition between vegetation communities hold concentrations of bird and frog species and range-limited species. They tested this, while taking into account the extent to which these relationships are being affected by environmental variables, specifically available environmental energy and topographic heterogeneity. Van Rensburg *et al.* (2009; *Diversity Distrib.* **15**, 379-389) reported that species richness and range size rarity across South Africa are generally negatively correlated with distance to transition areas between vegetation communities for both groups (Fig. 2).

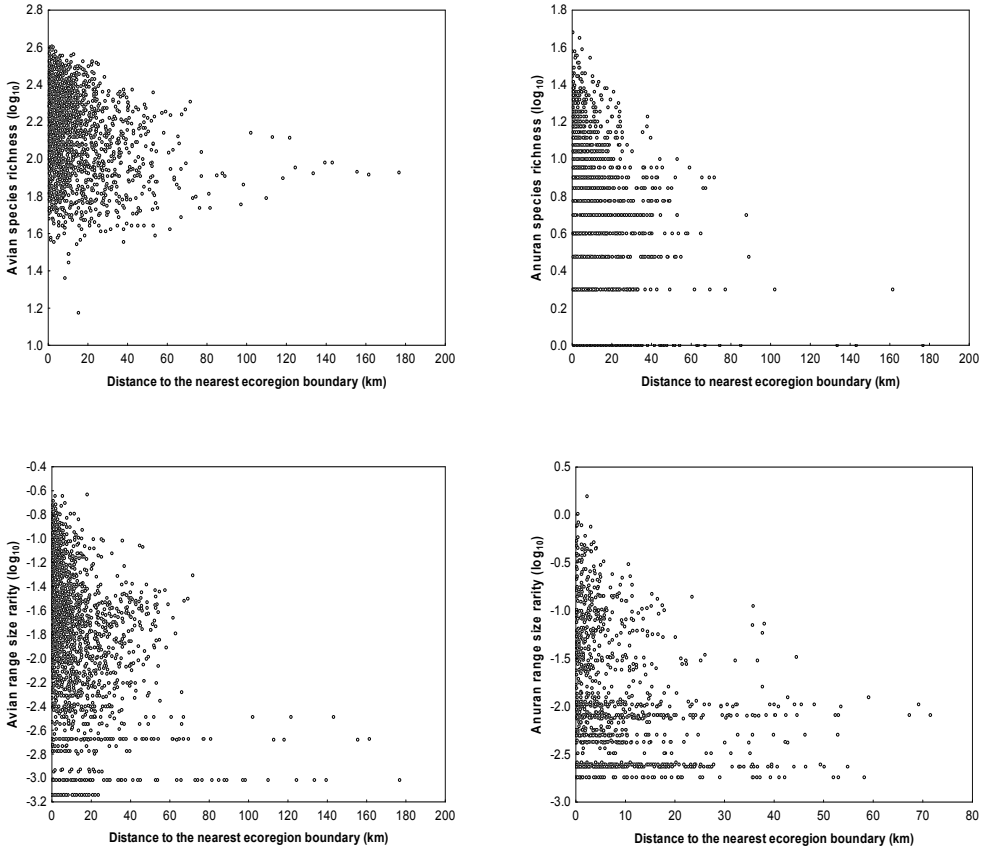

Figure 2. Relationships at the regional scale between avian and anuran species richness and range size rarity and distance to the nearest transition area between vegetation communities. **Top left**. Log avian species richness = 2.1934 – 0.0036 x distance to nearest vegetation boundary; r = -0.30; $p < 0.0001$; df = 1, 1856. **Top right**. Log anuran species richness = 0.85405 – 0.0067 x distance to nearest vegetation boundary; r = -0.31; $p < 0.0001$; df = 1, 1630. **Bottom left**. Log avian range size rarity = -1.682 – 0.0104 x distance to nearest vegetation boundary; r = -0.32; $p < 0.0001$; df = 1, 1807. **Bottom right**. Log anuran range size rarity = -1.778 – 0.0155 x distance to nearest vegetation boundary; r = -0.26; $p < 0.0001$; df = 1, 1142 (Reproduced from Van Rensburg *et al.* 2009; *Diversity Distrib.* **15**, 379-389).

Although this relationship becomes weaker after controlling for environmental energy and topographic heterogeneity, the explanatory power of distance to transition areas remained

significant. The researchers found that South African endemic and range-limited birds and frogs are located closer to ecological transition zones than endemics and non-endemics combined. This has important implications for ongoing conservation planning in a biogeographical context.

Fine-scale modelling of invasive insects – Argentine ants on the Iberian Peninsula as a model system

The Argentine ant (*Linepithema humile*) is one of the most troublesome and best-studied invasive species in the world. The species has received considerable attention from C·I·B-affiliated researchers in recent years, and much work is continuing with the aim of understanding the dynamics of spread of this species. C·I·B post-doctoral researcher Nuria Roura-Pascual and co-workers studied the Argentine ant on the Iberian Peninsula (Roura-Pascual *et al.* 2009; *Biol. Inv.* **11**, 1017–1031). They estimated the potential geographic distribution and ecological requirements of the species using ecological niche modelling, and provided new insights on the process of selection of consensual areas among predictions from several modelling methodologies. Ecological niche models were developed using five modelling techniques: generalized linear models (GLMs), generalized additive models (GAMs), generalized boosted models (GBMs), Genetic Algorithm for Rule-Set Prediction (GARP), and Maximum Entropy (Maxent). Models for the eastern and western portions of the Iberian Peninsula were constructed using subsets of occurrence and environmental data to investigate the potential for ecological niche differences between the invading populations. Results of the study revealed geographic differences between the predictions obtained using different approaches, and the utility of ensemble predictions in identifying areas of uncertainty regarding the species' invasive potential. The research showed that coastal areas and major river corridors are most suitable for the ants, and indicates that western and eastern Iberian Peninsula populations occupy similar environmental conditions. These insights are being used to develop a global model to explain intra-regional variation in distribution and abundance of the species.

Physiological studies on the determinants of range limits on Southern Ocean Islands

Despite the importance of understanding the mechanisms underlying range limits and abundance structure, few studies have sought to do so. C·I·B Ph.D. student Jennifer Lee and co-workers used a terrestrial slug species, *Deroceras panormitanum*, that has invaded a remote, largely predator-free, Southern Ocean island as a model system. Across Marion Island, slug density does not conform to an abundant centre distribution. Rather, abundance structure is characterized by patches and gaps (Fig. 4). These are associated with this desiccation-sensitive species' preference for biotic and drainage line habitats that share few characteristics except for their high humidity below the vegetation surface. The coastal range margin has a threshold form, rapidly rising from zero to high density. Slugs do not occur where soil-exchangeable Na values are higher than 3000 $mg.kg^{-1}$, and in laboratory experiments, survival is high below this value but negligible above it. Upper elevation range margins are a function of the inability of

this species to survive temperatures below an absolute limit of -6.4°C, which is regularly exceeded at 200 m altitude, above which slug density declines to zero. However, the linear decline in density from the coastal peak is probably also a function of a decline in performance or time available for activity. This is probably associated with an altitudinal decline in mean annual soil temperature. These findings support previous predictions made regarding the form of density change when substrate or climatic factors set range limits (Lee *et al.* 2009; *Proc. Royal Soc. B* **276**, 1459-1468).

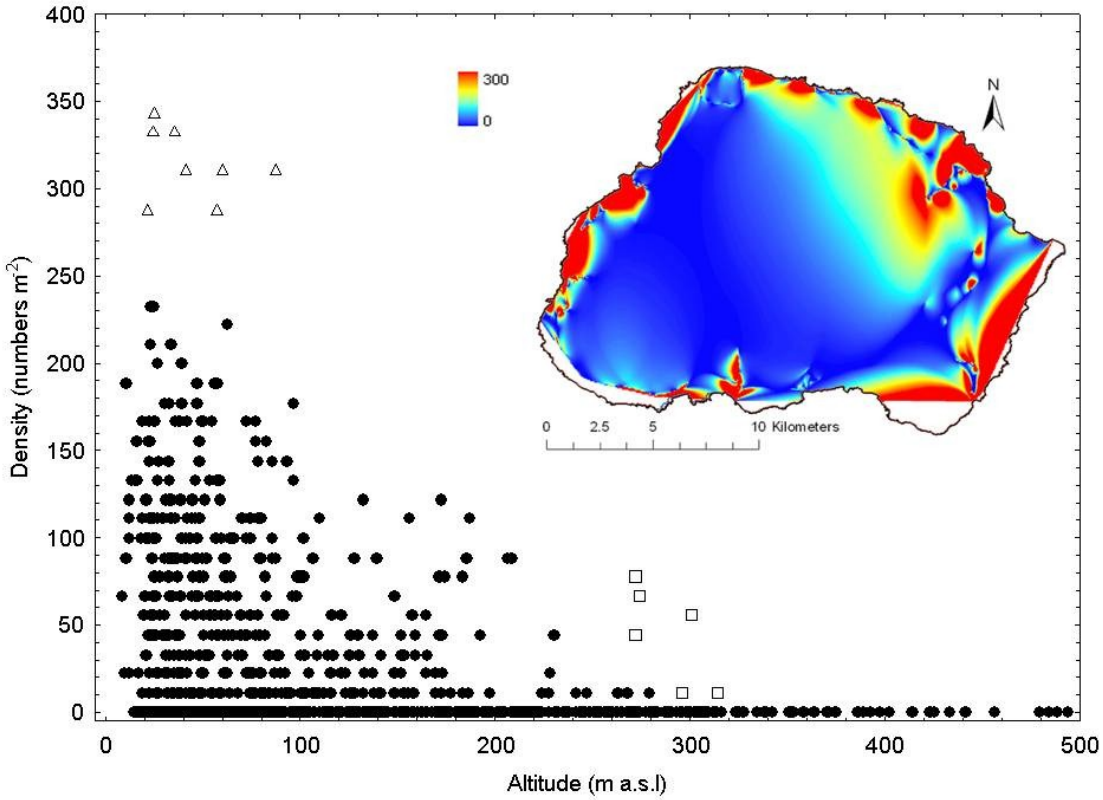

Figure 4. *Deroceras panormitanum* density plotted against altitude for all 1109 quadrats sampled on Marion Island. Open triangles indicate Trypot Beach on the east coast and the open squares the high altitude site above Mixed Pickle Cove. The inset shows the natural neighbour interpolation of slug density (numbers.m^{-2}) across the island (Reproduced from Lee *et al*. 2009; *Proc. R. Soc. B* **276**, 1459-1468)

Other work in Antarctic systems concerned the life history of nematodes on the continent. Soil biological studies have suggested that generations of terrestrial nematodes in continental Antarctica may take many years. Yeates *et al.* (2009; *Pedobiologia* **52**, 375-386) sampled soil nematodes at three sites in the Adelie penguin colony at Cape Hallett on four dates in a two month sampling period. The size-class distribution of over 3500 nematodes, and the occurrence of adults, indicates an annual life cycle of the bacterial-feeding *Panagrolaimus davidi* and *Plectus murrayi*, at each site. Nematode abundance ranged from 2 - 1375/g dry soil.

Moderate temperatures and the regular presence of free water underlie this biological activity and related contribution to soil processes.

Larger species also have considerable impacts on soil processes in the region. On Southern Ocean islands the effects of the house mouse on plants are not well understood. In particular, its influence at the landscape scale has largely been overlooked. To address this issue, C·I·B student Ethel Phiri systematically mapped the distribution of a keystone, cushion plant species, *Azorella selago*, and mouse damage to it across Marion Island. Mouse damage was observed in a third of the sampled sites from sea level to 548 m a.s.l. Damage to individual cushions ranged from single burrows to the disintegration of entire cushions (Fig. 5). Mouse damage was high in sites with low *A. selago* density, suggesting that in areas of low cushion density the impact of mice may be substantial. Moreover, it is not simply direct impacts on the *A. selago* population that are ecologically significant. *Azorella selago* cushions serve as nurse plants for many epiphyte species, so increasing the altitudinal range of a variety of them. Cushions also house high densities of invertebrates especially in fellfield landscapes. In consequence, this study demonstrates that mice are having a significant, negative impact at the landscape scale on Marion Island, so adding to the growing list of species and ecosystem-level effects attributable to this invasive rodent (Phiri *et al.* 2009; *Antarctic Sci.* **21**, 189-196).

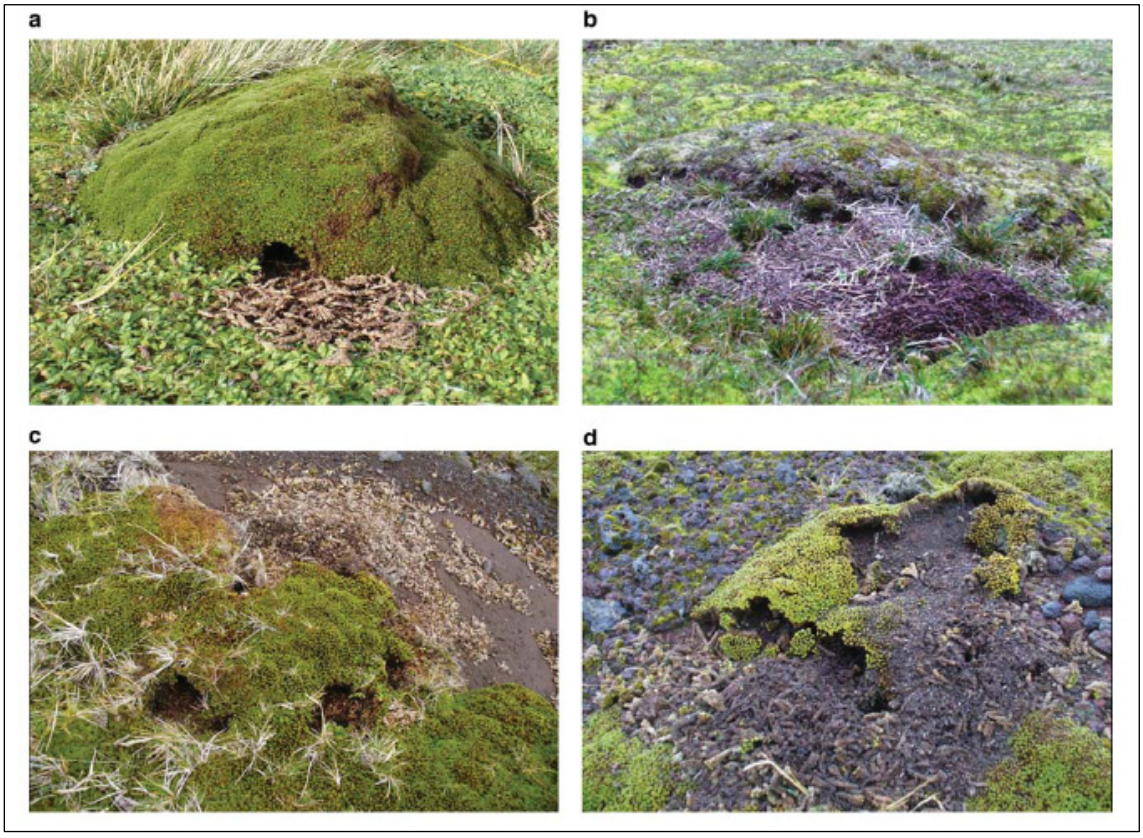

Figure 5. The observed mouse damage to *Azorella selago* cushions on Marion Island (in systematic and *ad hoc* plots). *Azorella selago* with **a.** a single burrow entrance, **b.** multiple burrow entrances, **c.** multiple burrow entrances and partial disintegration, and **d.** a disintegrated cushion where mouse burrow entrances are barely visible (Reproduced from Phiri *et al*. 2009; *Antarctic Sci*. **21**, 189-196)

Allee effects and self-incompatibility in invasive plants

It has been suggested that plants that are good colonizers will generally either be able to self-fertilize or have a generalist pollination system. This prediction is based on the idea that these reproductive traits should confer resistance to Allee effects in founder populations (Allee effects are a small-population phenomenon in which average individual fitness is a function of population size or density). C·I·B core team member Steven Johnson has a long-term interest in this question. He and co-workers undertook a study of the plant *Gomphocarpus physocarpus* (Apocynaceae), a species native to South Africa that is invasive in other parts of the world (Coombs *et al.* 2009; *Austr. Ecol.* **34**, 688-697). They found no significant relationships between the size of *G. physocarpus* populations and various measures of pollination success (pollen deposition, pollen removal and pollen transfer efficiency) and fruit set. A breeding system experiment showed that plants in a South African population are genetically self-incompatible and thus obligate outcrossers. Outcrossing is further enhanced by mechanical reconfiguration of removed pollinaria before the pollinia can be deposited. Self-pollination is reduced when such reconfiguration exceeds the average duration of pollinator visits to a plant. Observations suggest that a wide variety of wasp species in the genera *Belanogaster* and *Polistes* (Vespidae) are the primary pollinators.

The study concluded that efficient pollination of plants in small founding populations, resulting from their generalist wasp-pollination system, contributes in part to the colonizing success of *G. physocarpus*. The presence of similar wasps in other parts of the world has evidently facilitated the expansion of the range of this milkweed.

C. Molecular ecology and genetics of invasions

Colonization history of small mammals in Europe – mice, shrews and voles examined

Ongoing work by C·I·B core team member Victor Rambau and co-workers explored the dynamics of small mammals in Europe, focusing primarily on mitochondrial (mt) DNA loci, supplemented with bi-parentally inherited microsatellites, and restriction length polymorphisms (RFLP). They combined cytochrome b data from five species (bank vole, common shrews, field vole, pygmy shrew, and the house mouse) to determine the colonization history of small mammals in the United Kingdom. Specific mitochondrial mtDNA lineages of three small mammal species (bank vole, field vole and pygmy shrew) were found to have peripheral western/northern distributions in Britain with striking similarities to that of 'Celtic' people (Searle *et al.* 2009; *Proc. R. Soc. B.* **276**, 4287-4294).

The implication is that these small mammals most likely colonized Britain in a two-phase process, with climatically-driven partial replacement of the first colonists by the second colonists, leaving a peripheral geographic distribution for the first colonists. These natural 'Celtic fringes' provide insight into the same phenomenon in humans and, in turn, the human 'Celtic fringe' directly explains the peripheral distribution of an mtDNA lineage in an introduced commensal species (the house mouse). These results are unique in that they show that small mammal movements closely correspond with prehistoric human settlements, and

therefore indicate that the genetic signature of small mammals can be used as a surrogate to trace recent global human colonizations. The research also showed that phylogeography of the house mouse was largely influenced by Norwegian Vikings during the Iron Age, who accidentally transported the mice and founded viable populations in human settlements.

Another study explored whether the pygmy shrew is a native or has been introduced to Ireland (McDevitt *et al.* 2009; *Biol. J. Linn. Soc.* **97**, 918-927). The researchers employed the control region and five polymorphic loci, from which they retrieved low genetic diversity for both markers. This is indicative of a founder effect, suggesting that Ireland was colonized by a small number of individuals that later spread to the whole of Ireland. Dating of both markers suggests that expansion of the population occurred between 9 000 and 18 000 years ago. This estimate places the expansion event between the retreat of the glacial ice sheet at the end of the Last Glacial Maximum and the arrival of human settlers in Ireland. Further, the absence of similar species in Ireland such as the common shrew and vole species present on mainland Britain) provides indirect evidence that colonization of the Irish shrew was human mediated as opposed to a natural colonization.

A tale of rarity and abundance in the Cape Floristic Region

Oxalis is the largest and most diverse genus in the family Oxalidaceae and is the seventh largest genus in the Cape Floristic Region. Within southern Africa, this genus is represented by ~ 270 taxa, the majority occurring in the Cape Region. Although a small proportion of *Oxalis* species has very wide distributions and ecological tolerances, most conform to the pattern in other CFR taxa by being highly localized, often also with specific habitat preferences. Work on this genus is also interesting and important because several species are serious weeds in other parts of the world.

Core team member Bettine Jansen van Vuuren and collaborators assessed the degree of genetic differentiation between two rare and highly localized *Oxalis* species (*O. hygrophila* and *O. oligophylla*) and the more widespread *O. tomentosa*. For comparative purposes, they also included *O. purpurea*, one of the most widely distributed species in South Africa and often considered a weedy species (see Fig. 6 for the respective distribution ranges of the species).

The specific objective was to determine whether geographic occurrence (highly localized vs. widespread vs. weedy) was reflected in the species' respective genetic profiles, with weedy species expected to have the highest genetic diversity and geographically localized species being characterized by lower levels of variation. Chloroplast sequences of the trnH/psbA spacer revealed low genetic diversity for *O. oligophylla* and *O. tomentosa* compared to the widespread *O. purpurea*. For example, a single genetic haplotype (A) characterized 20 specimens belonging to *O. oligophylla* compared to five haplotypes (E-K) characterizing 15 *O. purpurea* specimens (Fig. 7). High genetic diversity in *O. purpurea* might, in combination with other ecological and reproductive factors, account for the success of this species and contribute to its weediness. In contrast, low variation might contribute to rarity in *O. oligophylla* and ultimately lead *O. tomentosa* to become rare (Zietsman *et al.* 2009; *S. Afr. J. Bot.* **75**, 27-33).

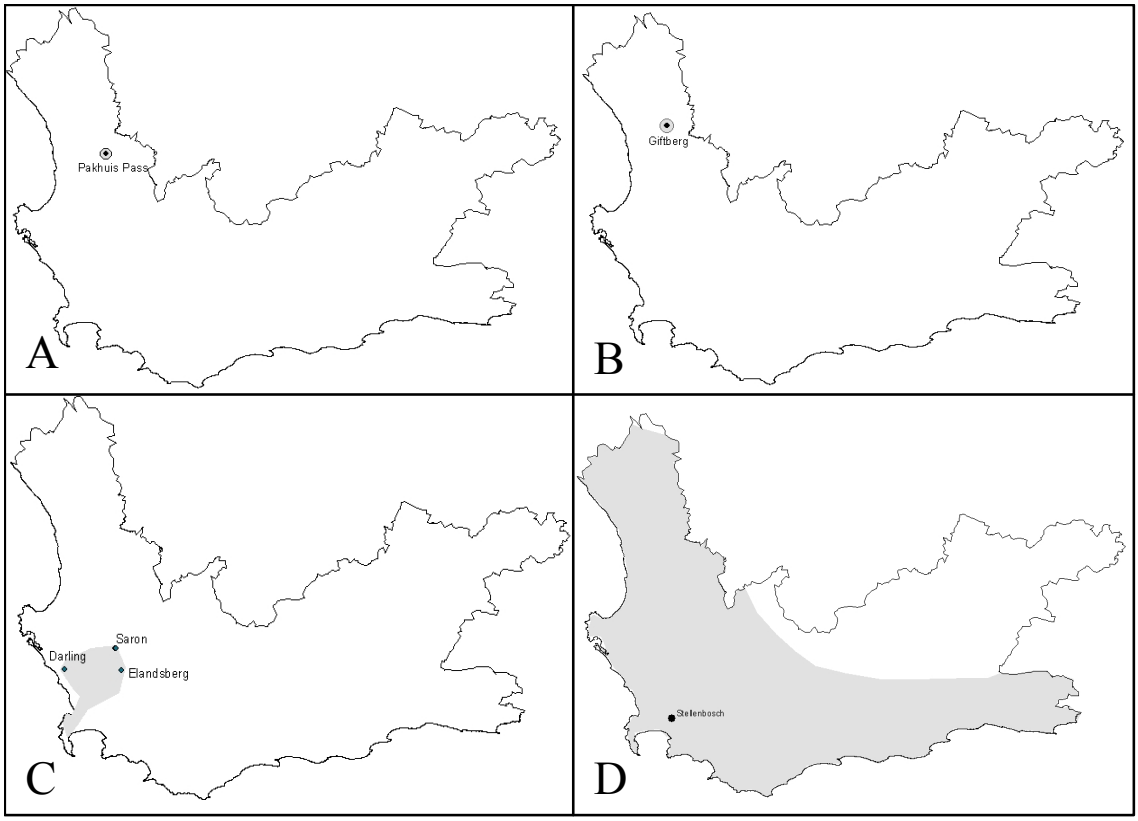

Figure 6. The geographic distribution of **B**. *Oxalis oligophylla*, **C**. *O. tomentosa* and **D**. *O. purpurea* in the Western Cape Province, South Africa. Specific study sites of each species are indicated in black (Reproduced from Zietsman *et al*. 2009; *S. Afr. J. Bot*. **75**, 27-33)

D. Global environmental change, biological invasions, ecosystem services and sustainability

Spatial congruence between biodiversity and ecosystem services in South Africa

South Africa, with its rich biodiversity, varied topography and diversity of biomes, has been termed 'a world in one country'. The country has a strong history of reasonably effective measures to conserve representative portions of its natural capital and biodiversity. However, with escalating threats in the form of increasing habitat transformation and ever-increasing impacts of invasive alien species, additional measures are needed to ensure more and better conservation. Ecosystem services are crucial for human wellbeing over large parts of South Africa. The maintenance of ecosystem services is often used to justify biodiversity conservation actions, but crucial information on how ecosystem services relate to different aspects of biodiversity and the extent to which conserving biodiversity will safeguard ecosystem services is lacking.

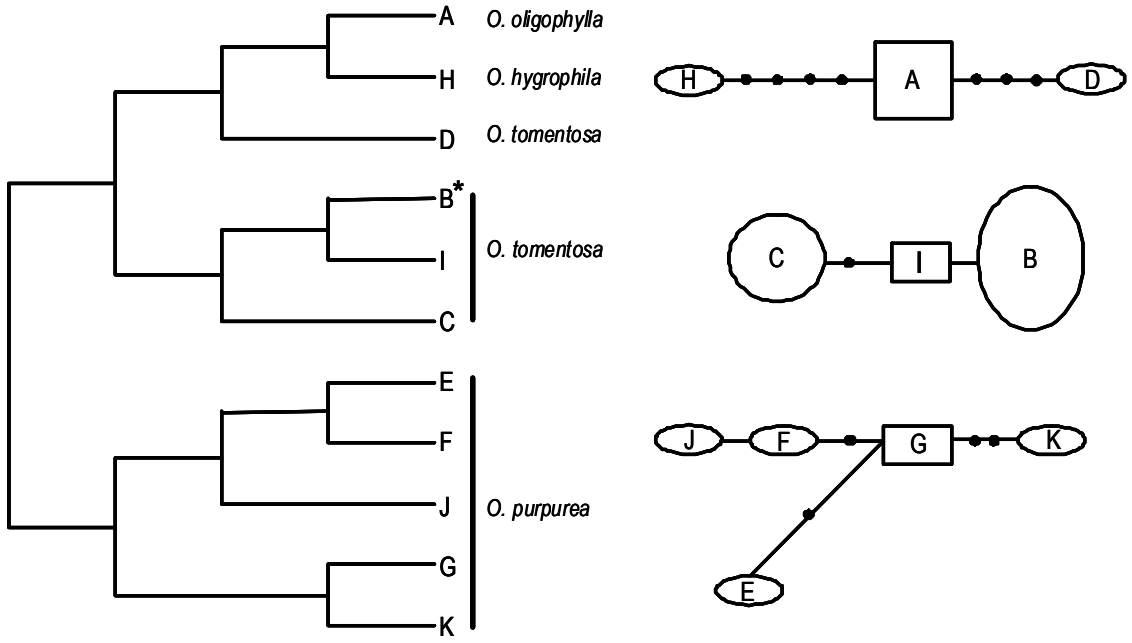

Figure 7. **A**. Parsimony analyses of the *Oxalis* species studies recovered a single most parsimonious tree of 55 steps (CI=0.865). Bootstrap support (parsimony/maximum likelihood), following 1000 replicates, is indicated above branches. * denotes a bootstrap value below 60%. **B**. The minimum spanning network, depicting the least number of mutational steps separating haplotypes, is shown. The 95% connection limit was set at 6 steps, resulting in three separate networks with congruence to the parsimony topology (Reproduced from Zietsman *et al*. 2009; *S. Afr. J. Bot*. **75**, 27-33)

C·I·B Ph.D. student Benis Egoh conducted a study to examine whether biodiversity priorities, biomes, species richness and vegetation diversity hotspots co-occur in space with ecosystem services in South Africa (Egoh *et al.* 2009; *Biol. Conserv.* **142**, 553-562.). The distribution of the ranges and 'hotspots' (areas which provide large components of a particular service) of five ecosystem services (surface water supply, water flow regulation, carbon storage, soil accumulation, and soil retention) was assessed in South African biomes. Coincidence, overlap, and correlation analyses were used to assess spatial congruence between ecosystem services and species richness (plants and animals) and vegetation diversity hotspots.

Results showed that the grassland and savanna biomes contained significant amounts of all five ecosystem services. There was moderate overlap and a generally positive but low correlation between ecosystem services hotspots and species richness and vegetation diversity hotspots. Species richness was higher in the hotspots of water flow regulation and soil accumulation than would be expected by chance. The water services showed varying levels of congruence with species richness hotspots and vegetation diversity hotspots. These results indicate that actions taken to conserve biodiversity in South Africa (including actions to reduce the impacts of invasive species) will also protect certain ecosystem services and that ecosystem services can be used to strengthen biodiversity conservation in some instances. This information will be useful for long-term planning of priorities for the management of invasive species.

Perennial grass invasion, fire and grazing capital of the karoo

Grass invasions are of particular concern in arid ecosystems where indigenous standing fuel rarely reaches levels to support fire. With this in mind, C·I·B Ph.D. student Seb Rahlao conducted an experiment to assess the effects of fire following invasion by fountain grass *P. setaceum*, in arid Karoo shrublands (Rahlao *et al.* 2009; *Austral Ecol.* **34**, 920-928.). Replicated plots with added grass fuel were burnt, and recovery was compared to unburnt control plots. After 15 months of follow-up monitoring, only two species, the dwarf shrub (*Tripteris sinuata*) and the perennial herb (*Gazania krebsiana*) had resprouted in the burnt plots (Fig. 8). Most individuals of other species were killed and did not reseed during the study. The results have important implications for predicting the effects of invasive alien plants (especially grasses) on fire-free ecosystems in the Karoo and elsewhere. Should future invasions by *P. setaceum* lead to similar fuel loads in these shrublands, inevitable fires could dramatically alter species composition and dominance patterns in the vegetation, and may favour spread of flammable grasses. This will ultimately affect core natural resources that support the vulnerable economies of these agriculturally marginal systems.

Figure 8. **Left**. The pre-burn survey indicating the typical Karoo vegetation as a sparse (25% cover), low shrubland dominated by succulent (Mesembryanthemaceae) and non-succulent shrubs (mostly Aizoaceae and Asteraceae); **Centre**. After adding grass fuel replicated plots were burnt (December 2006), most of the Karoo species burned easily once the fire was initiated and the fire did not extend beyond the plots where fuel was added; **Right**. Fifteen months after the fire the burnt areas were still bare, although some herbs and shrubs had resprouted (Photos: Seb Rahlao).

Ungulate invasions unravelled

A review by former C·I·B Ph.D. student Dian Spear and Steven Chown examined the evidence for the impacts of introduced ungulates (Spear & Chown 2009; *J. Zool.* **279**, 1-17). Non-indigenous ungulate species are thought to pose a problem for conservation. They can be socially and economically valuable, but are also potentially harmful to biodiversity. Therefore, their introduction requires an explicit assessment of risk relative to benefit. To conduct such risk assessments, information regarding the impacts of non-indigenous ungulates on biodiversity is required. The researchers reviewed the available evidence for the biodiversity impacts of non-indigenous ungulates. Hybridization, exploitation and apparent

competition, vegetation impacts, predation, facilitation, trophic cascades and soil system functioning were assessed using a hierarchical set of criteria for the strength of the evidence. Strong evidence was lacking for risks posed by competition. Numerous reports exist of hybridization in captivity between ungulate species that normally do not co-occur, but conclusive evidence for introgression in the wild was restricted to one case. Strong evidence (using exclosure experiments) for the impacts of introduced ungulates on vegetation structure and composition was found and in some cases introduced ungulates caused the extirpation of plant species. Predation by *Sus scrofa* is a substantial threat to island faunas and systems, and impacts on soil system functioning elsewhere have also been found. Facilitation by ungulates has been shown to be substantial in promoting invasive plant species. By contrast, little evidence exists for apparent competition. The largest impacts from introduced ungulates are likely to be in cases where they perform novel functions in the new environment. However, to determine which types of impacts are likely to be most problematic, further evidence is required, ideally from well-designed field experiments.

In another study, Spear & Chown (2009; *Biol. Conserv.* **142**, 353-363) examined the pathways of introduction, propagule pressure and realized impacts of ungulate introductions to South Africa within a global context. Across countries globally, introduced ungulate richness is not related to indigenous ungulate richness, and several countries are clear outliers. South Africa is second only to the USA in the number of ungulate species introduced to date. Zoos have traded more ungulate species and individuals to non-zoo recipients than to other zoos, highlighting the tensions that exist between *in situ* and *ex situ* conservation goals. Introductions to South Africa, and extralimital introductions within the region, have increased through time, with propagule pressure being highest in areas with high human population density. The long distances ungulates have been translocated raise concerns for genetic homogenization. Translocations of indigenous ungulate species extralimitally have significantly altered range sizes, typically to a greater extent than is expected from range shifts associated with global climate change. Although ungulate introductions and translocations are likely to have impacts on biodiversity, evidence for such impacts in South Africa, and elsewhere, is limited. Whilst arguments may be made for a precautionary approach to ungulate introductions, an evidence-based one is much more likely to deliver efficient and convincing conservation decision-making.

E. Detection, deterioration, restoration and re-introduction

Kangaroo thorn and kangaroo paws – two Australian species targeted for eradication in South Africa

The Australian tree, *Acacia paradoxa* (kangaroo thorn) is one of several Australian acacias that occurs in South Africa but which has not invaded over large areas. The species is listed under the Conservation of Agricultural Resources Act as a Category 1 invasive plant and, until 2008, was managed as part of Working for Water's general alien clearing operations. *Acacia paradoxa* is currently restricted to a small population on the northern slopes of Devil's Peak, Table Mountain National Park in the Western Cape (Fig. 9). Honours student Rafael Zenni

undertook a detailed study to assess whether it would be feasible to eradicate the species. 11 350 plants were mapped over an area of 295 ha. The distribution of the species is highly clumped, and at a local scale it has formed thick stands of up to 20 plants m^{-2}. A bioclimatic model showed that the species has a large potential distribution in South Africa, especially along the southern coast. Observations on Table Mountain confirmed that the species has the ability to transform ecosystems.

The population on Table Mountain appears to be spreading slowly, and, while there is a significant seed bank in some places (~1000 seeds m^{-2}), this is largely restricted to areas below the canopy of existing plants. Therefore, the population has not and likely will not rapidly spread in area, and so containment is feasible. Dedicated and thorough annual follow ups are required because plants can produce seeds when they are one year old and standard clearing operations have missed flowering plants. Results of this study were published in *South African Journal of Botany* (Zenni *et al.* 2009; *S. Afr J. Bot.* **75**, 485-496).

Figure 9. *Acacia paradoxa*, a small Australian shrub growing in Table Mountain National Park, with the city of Cape Town in the background. Although the species currently occupies about 295 ha at this locality, and forms impenetrable stands over large areas there, it is not known to occur anywhere else in South Africa. Studies involving the C·I·B are exploring the feasibility of eradicating this and several *Acacia* species in South Africa (Photo: R. Zenni).

The results of this work have fed directly into a new management plan for the species as part of the Early Detection and Rapid Response Programme. The management of *Acacia paradoxa* is now a joint effort between Working for Water, SANParks, SANBI and the C·I·B. Most adult plants were cleared by early 2009, with additional work continuing in 2010. The work has been expanded, in particular to study seed bank dynamics and the effect of fire on control, and all results are feeding directly into management. *Acacia paradoxa* is being used as the case study template for the Early Detection and Rapid Response Programme.

Coincidentally, another 'kangaroo' from Australia, this time kangaroo paw (*Anigozanthos* sp.) was also the focus of attention during 2009. The C·I·B is providing research input in assessing the feasibility of eradication for such species as part of the collaborative project with the Working for Water programme on *Research for Integrated Management of Invasive Alien Species*.

Propagule pressure as a driver of invasions in Antarctica

Although the impacts of biological invasions are widely appreciated, a bias exists in research effort in favour of post-dispersal processes because of the difficulties of measuring propagule pressure. The Antarctic provides an ideal model system in which to investigate propagule movements because of the region's isolation and small number of entry routes. As part of her Ph.D. project Jennifer Lee, working with Steven Chown, investigated the logistics operations of the South African National Antarctic Programme (SANAP) and quantified the initial dispersal of alien species into the region. Their paper (Lee & Chown 2009; *Ecol. Appl.* **19**, 1944-1959) reported that over 1400 seeds from 99 taxa are transported into the Antarctic each field season in association with SANAP passenger luggage and cargo. The first ever assessment of propagule drop-off indicated that 30–50% of these propagules will enter the recipient environment. Many of the taxa include cosmopolitan weeds and known aliens in the Antarctic, indicating that logistics operations form part of a globally self-perpetuating cycle moving alien species between areas of human disturbance. In addition, propagules of some taxa native to the Antarctic region were also found, suggesting that human movements may be facilitating intra-regional homogenization. Several relatively simple changes in biosecurity policy that could significantly reduce the threat of introduction of non-native species were suggested.

In another study (Lee & Chown 2009; *Antarctic Sci.* **21**, 471-475) these authors quantified the propagule pressure associated with the construction of a research station in Antarctica. Based on quantitative assessment of different classes of cargo, they predicted that over 5 000 seeds will be entrained during the period of building the station. Seeds from 34 taxa were identified, including known invasive species.

The outcomes of this work were fed directly into policy for the region via the South African Working paper to the Committee for Environmental Protection at the Antarctic Treaty Meeting held in Baltimore U.S.A. in 2009 (ATCM XXXII, WP 23).

Mayhem on Macquarie Island – an expensive lesson for invasive species management

Owing to the detrimental impacts of invasive alien species, their control is often a priority for conservation management. Whereas the potential for unforeseen consequences of management is recognized, their associated complexity and costs are less widely appreciated. A study involving C·I·B Director Steven Chown, working with Dana Bergstrom and others and published in *Journal of Applied Ecology*, showed that theoretically plausible trophic cascades associated with invasive species removal not only take place in reality, but can also result in rapid and drastic landscape-wide changes to ecosystems (Fig. 10). Using a combination of

population data of an invasive herbivore, plot-scale vegetation analyses, and satellite imagery, the authors showed how a management intervention to eradicate a mesopredator has inadvertently and rapidly precipitated landscape-wide change on sub-Antarctic Macquarie Island. This happened despite the eradication being positioned within an integrated pest management framework. Following eradication of cats *Felis catus* in 2001, rabbit *Oryctolagus cuniculus* numbers increased substantially although a control action was in place (*Myxoma* virus), resulting in island-wide ecosystem effects. The results highlighted an important lesson for conservation agencies working to eradicate invasive species globally; that is, risk assessment of management interventions must explicitly consider and plan for their indirect effects, or face substantial subsequent costs. On Macquarie Island, the cost of further conservation action will exceed AU $ 24 million (Bergstrom *et al.* 2009; *J. Appl. Ecol.* **46**, 73-81).

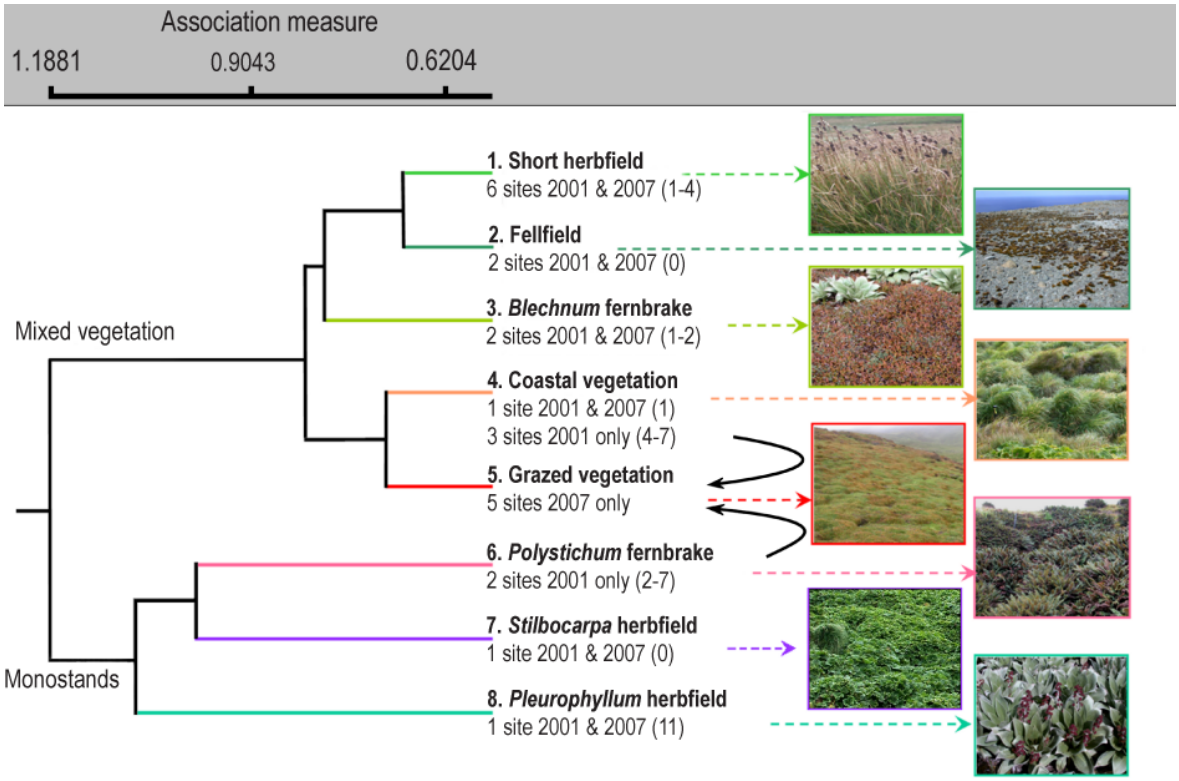

Figure 10. Classification dendrogram of the 18 sites depicting the eight vegetation groups. Five sites from two vegetation groups (tall coastal vegetation or *Polystichum* fernbrake) had undergone extensive change to grazing lawns between 2001 and 2007, as indicated by the recurved black arrows. In addition 10 sites had also changed, although remained in their original (2001) vegetation group. Change is indicated by the range of new taxa found within sites in 2007 compared with 2001 for each group (within brackets) (Reproduced from Bergstrom *et al*. 2009; *J. Appl. Ecol*. **46**, 73-81).

This paper generated considerable media attention and correspondence in the *Journal of Applied Ecology*. The original paper showed that feral cats on Macquarie Island were exerting top-down control on the feral rabbit population, and that the eradication of the cats led to a substantial

increase in rabbit numbers and an associated trophic cascade. In responding to the paper, Dowding *et al.* (2009; *J. Appl. Ecol.* **46**, 1129-1132) claimed that the modelling was flawed for various reasons, but primarily because a reduction in the application of the rabbit control agent, *Myxoma* virus, coinciding with cat removal, was a major driver of rabbit population release.

In their response, Bergstrom et al. (2009; *J. Appl. Ecol*. **46**, 1133-1136) explored this proposition and others by examining rates of *Myxoma* viral release between 1991 and 2006 in association with presence/absence of cats against two estimates of rabbit population size. *Myxoma* viral release was a significant factor in the lower estimates of rabbit population, but the effect was small, and was not significant for higher rabbit population estimates. By contrast, the presence or absence of cats remained highly significant for both estimates. Thus, Bergstrom *et al.* dispensed with the concerns raised by Dowding *et al.* (2009) and provided further support for their position that top-down control of rabbit numbers by cats, prior to their eradication, was occurring on Macquarie Island. Nonetheless, they agreed with Dowding *et al.* (2009) that systems with multiple invasive species represent complex situations that require careful scrutiny. Such scrutiny should occur in advance of, during, and following management interventions.

Summarizing declines in species diversity due to alien plant invasions in Mediterranean-type ecosystems

It is widely stated that invasive alien species have a negative impact on biodiversity. Besides the strong evidence for the negative impacts of some vertebrate species, especially on islands, there is surprisingly little hard data, especially for plant invasions. Only recently has the decline of native species attributable to biological invasions begun to be quantified in many parts of the world. Nonetheless, the cause-effect relationship between the establishment and proliferation of alien species and the extinction of native species is seldom demonstrated.

A team of researchers at the C·I·B set out to explore the evidence for impacts of alien plant invasions on native plant biodiversity in Mediterranean-type ecosystems, using a meta-analysis of published information. Their meta-analysis, which appeared in *Progress in Physical Geography* examined: (1) whether invasion of alien plant species indeed causes a reduction in the number of native plant species at different spatial and temporal scales; (2) which growth forms, habitat types and areas are most affected by invasions; and (3) which taxa are most responsible for native species richness declines.

Their results confirm a significant decline in native species richness attributable to alien invasions. They found that studies conducted at small scales or sampled over long periods reveal stronger impacts of alien invasion than those at large spatial scales and over short periods. Alien species from regions with similar climates have much stronger impacts, with the native species richness in South Africa and Australia declining significantly more strongly after invasion than is the case for European sites. Australian *Acacia* species in South Africa caused the most significant declines in native species richness (Fig. 11). Among the different growth forms of alien plants, annual herbs, trees and creepers had the greatest

impact, whereas graminoids generally caused insignificant changes to the native community. Native species richness of shrublands, old fields, and dune vegetation showed significant declines, in contrast to insignificant declines for forest habitats.

Habitat destruction deconstructed

Two principal factors causing current global biodiversity loss are habitat destruction and biological invasions. Habitat destruction, consisting of two processes (loss and fragmentation), can change continuous habitats into isolated suitable patches. Species inhabiting such habitats have to form a metapopulation linked by migration between patches. Work involving C·I·B researcher Cang Hui has shown that the spatial heterogeneity caused by habitat destruction can cause a substantial effect on the spread or the transmission of epidemics and parasites (Su *et al*., 2009; *Ecol. Res.* **24,** 889-896; Su et al., 2009 *Ecol. Mod.* **220,** 51-59). Furthermore, when combined with the Allee effect (difficulty of growing when population density is low), habitat destruction can cause increased extinction debt, and threaten not only the stronger competitors, but also strong colonizers (Chen & Hui, 2009; *Math. Biosci.* **221,** 26-32).

Figure 11. A meta-analysis of the impacts of alien plant invasions on native plant invasions in Mediterranean-climate ecosystems showed that invasions of Australian *Acacia* species, such as this dense stand of *A. saligna* near Tulbagh in the Western Cape, have among the greatest negative impacts of any study so far. Photo: DM Richardson.

Impact of a dam on benthic macroinvertebrates in the Cape Floristic Region

Suitable reservoirs and monitoring methods are needed to manage scarce water supplies in dry countries. C·I·B student Emile Bredenhand and core team member Michael Samways assessed the impact on aquatic macroinvertebrates of the only dam on the Eerste River, which

runs through the heart of a biodiversity hotspot, the Cape Floristic Region, South Africa. The dam and associated activities were the only forms of disturbance in this otherwise pristine area. They sampled over 20 000 macroinvertebrate individuals and illustrated some categorical effects of the impoundment and its effects on macroinvertebrate assemblages. Macroinvertebrate species diversity below the dam was only half of that in the pristine catchment area above the dam. Furthermore, Ephemeroptera, Plecoptera and Trichoptera diversity and abundance dropped to almost zero as a result of the impoundment. In contrast, the abundance of the Diptera family Chironomidae increased substantially below the dam. These changes in macroinvertebrate diversity mirrored those recorded in biologically less diverse areas, but are of major concern in this biodiversity hotspot with its rich endemic fauna. The authors conclude that such an impoundment, while important for human welfare, results in a high price being paid in terms of loss of local biodiversity (Bredenhand & Samways 2009; *J. Insect Conserv.* **13**, 297-307).

F. Risk assessment, indicators and policy

Towards a quantitative climate-match score for assessing the risk of invasion for introduced reptiles

It has long been known that climate plays a crucial role in shaping the distribution range of any species. Consequently, attempts to match climatic features of target areas with those of areas where a particular species is native or is invasive have been a central part of defining invasion risk. With the increasing availability of global climate databases and ever-increasing sophistication of models for analysing climatic features, this is a very active area of research.

As part of her Ph.D. thesis on strategies for risk assessment for introduced reptiles, C·I·B student Nicola van Wilgen examined two approaches for modelling climatic suitability for reptile and amphibian species introduced to California and Florida. These regions were chosen because detailed data are available on the outcome of introductions (in most parts of the world failed introductions are poorly documented). Firstly, she modelled the worldwide distribution of the biomes found in the introduced range to highlight similar areas worldwide from which invaders might arise. She then modelled potentially suitable environments for species based on climatic factors in their native ranges, using three sources of distribution data. Performance of the three datasets and both approaches were compared for each species. Climate match was indeed found to be positively correlated with species establishment success. Furthermore, data from different sources produced considerably different results in some cases. Data assembled through the Global Amphibian Assessment provided the most accurate predictions for amphibians, while data compiled by the WWF yielded models which described reptile climatic suitability better than available museum data (see Fig. 12 for an example). Though point data is considered better for use in model building, the museum data did not cover sufficient portions of many species ranges to be used at this scale. In order to make the work accessible to decision makers, three methods of assigning a climate-match score for use in risk assessment have been detailed. The recommendation that emerges from this work (Van Wilgen *et al.* 2009; *Environ. Manage.* **44**, 590-607) is that both the mean and

maximum climatic suitabilities should be used to define such a score. In this way, managers may objectively evaluate species, facilitating higher resolution and accuracy for herpetofaunal risk assessment. Managers should, however, be aware that climate matching has inherent limitations and other factors pertaining to ecological interactions and life-history traits must also be considered for thorough risk assessment.

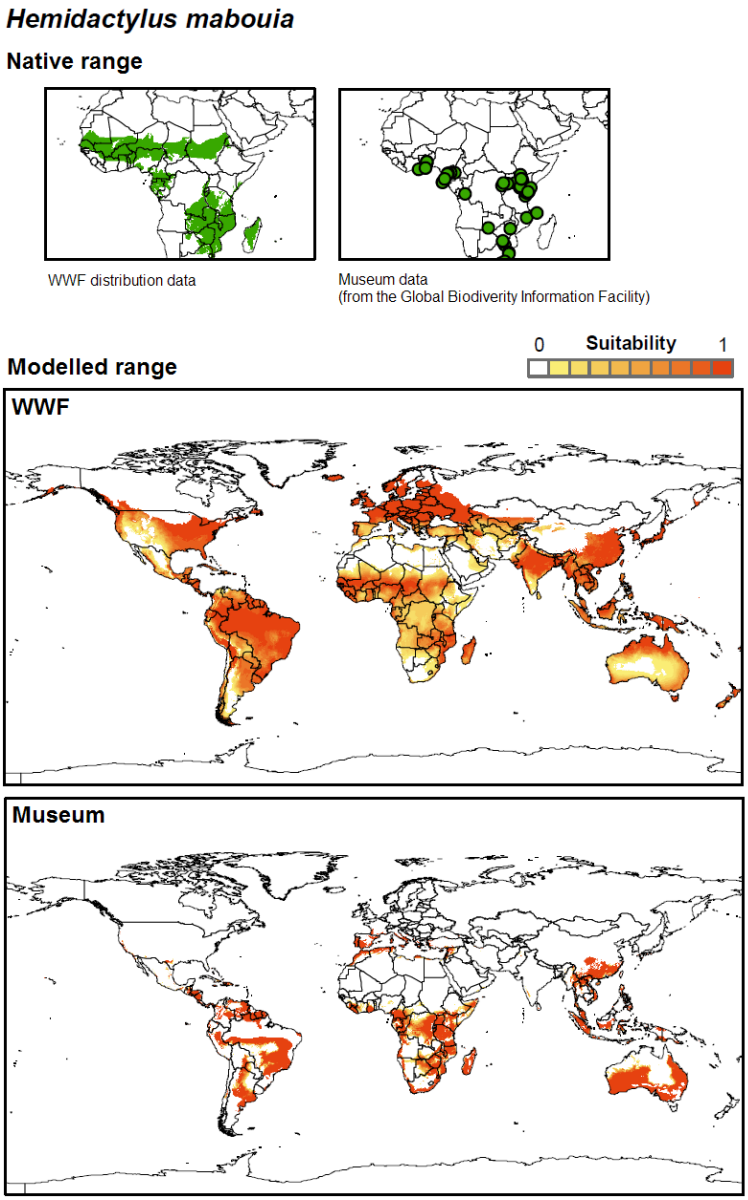

Figure 12. The native range of the tropical house gecko (*Hemidactylus mabouia*) obtained from two sources (WWF and the GBIF) and the global predictions obtained from these two data sources.

Getting to grips with gene flow of *Brassica* in the Fynbos

Gene flow from crops to wild relatives has been associated with the evolution of weediness in seven of the world's 13 most important crops. In addition, of the environmental risks posed by transgenic crops, those associated with the transfer of transgenes are considered to be most important. One of the species of concern is *Brassica napus* L. (Brassicaceae), i.e. canola or oilseed rape. *Brassica napus* has a number of characteristics favouring gene flow and a potential increase in weediness, and is becoming one of the most important sources of oil and protein in the world. In addition, transgenic, insect resistant and herbicide tolerant *B. napus* varieties have been developed and tested in field experiments.

McGeoch *et al.* (2009; *S. Afr. J. Sci.* **105**, 109-115) quantified the diversity of wild and weedy *B. napus* relatives and assessed the spatial congruence of their distributions as a basis for understanding the potential for gene flow from commercially produced *Brassica napus* to wild and weedy relatives in Fynbos. The Fynbos biome is a globally significant centre of biodiversity and endemism that is highly susceptible to plant invasions. The biome also encompasses the majority of the area planted to *B. napus* in South Africa. Based on literature information and the field survey conducted as part of this study, 27 relatives of *B. napus* were identified as occurring in South Africa. This includes both alien (mostly naturalised) and indigenous species. There is significant overlap between *B. napus* fields and the distribution of several wild and weedy relatives of *B. napus* in the Fynbos biome (Fig. 13). Amongst the naturalised (and weedy) species, *Rapistrum rugosum, B. tournefortii, Raphanus raphanistrum* and *Hirschfeldia incana* are considered to be of the highest priority for further gene flow and hybridisation risk assessment. All four species are prevalent in the Fynbos biome, are spatially congruent with *B. napus* and have elsewhere been shown to have some degree of reproductive compatibility with *B. napus*.

The results of this study provide a first step in the risk assessment for gene flow between *B. napus* and its relatives in the Fynbos biome. They clearly demonstrate that further attention must be given to ecological risk assessment for *B. napus* in this biodiversity rich region of South Africa, and identify priority species for further attention. Ecological risk assessment will be particularly critical if transgenic *B. napus* is to be considered for release, or if *B. napus* is to be used for agrofuel production (with a likely concomitant increase in area planted in the country). However, significant hurdles to ecological risk assessment for *B. napus* currently include: (i) the remaining uncertainties in the phylogeny and relatedness of taxa in the Brassicaceae, (ii) difficulties with morphology-based identification of these species generally and in South Africa, and (iii) the lack of taxonomic expertise, and (iv) poor knowledge of the distribution, phenology, pollination syndromes and reproductive mechanisms, particularly, but not only, of indigenous taxa.

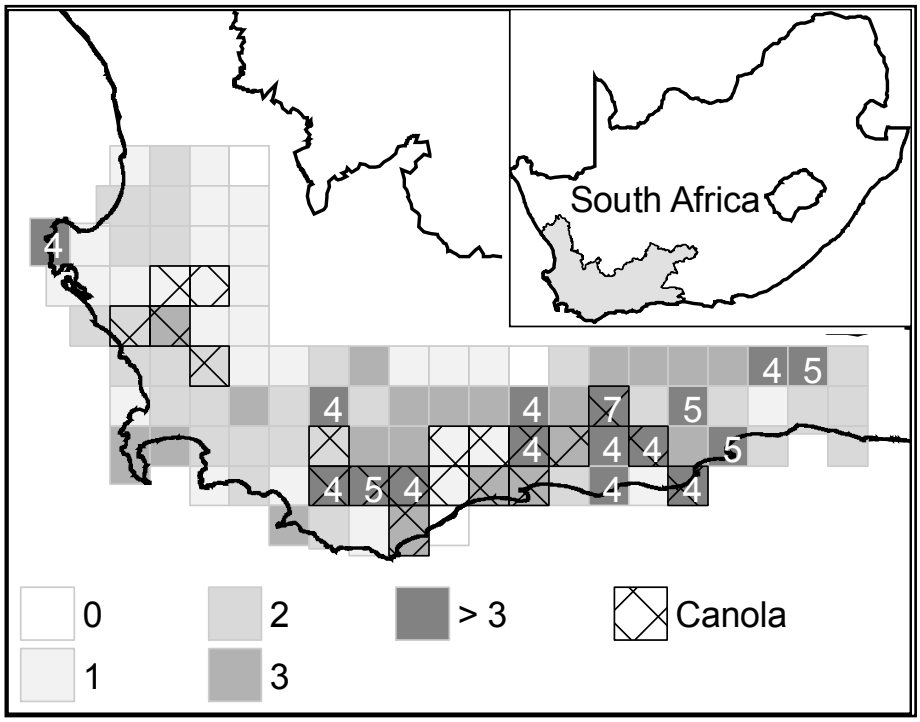

Figure 13. Species richness of relatives of *Brassica napus* in surveyed quarter degree squares (QDS) across the Fynbos biome (Western Cape Province, South Africa). In cells with greater than three species the number of species recorded is shown.

Science, policy, and management of invasive animals

A review of the impacts and control options for various invasive species and the extent to which science influences policy was published in *African Zoology* by invitation. Steven Chown and co-authors reviewed the broader ecological and conservation lessons from recent work on non-indigenous species in two southern systems, the policy implications thereof, and the subsequent changes to policy as a result of this work. They discussed invasions in the Antarctic region. Strong relationships exist between numbers of animal invasions and numbers of human visitors to Southern Ocean Islands, abiotic factors are often limiting for introduced species, homogenization across islands differs among taxonomic groups, and control actions can rapidly result in unintended consequences. This knowledge has influenced national policy and decisions within the Antarctic Treaty System. The review also examined ungulate introductions and translocations, both in South Africa and elsewhere. Substantial homogenization has resulted from both processes. However, firm evidence for impacts of ungulate introductions and translocations is sometimes difficult to find, despite the theoretical likelihood thereof. The paper argued that such a lack of information may have profound consequences for the effective implementation of policy (Chown *et al.* 2009; *African Zool.* **44**, 248-262).

G. Invasion, science, and society

The way that species are introduced makes a massive difference

An ongoing debate is taking place about the foundation and definition of biological invasions. This is not purely semantic—if biological invasion is a distinct phenomenon that requires describing, then there are concomitant implications for legislation, natural resource management, and ecology. If not, then the study of biological invasions is a diversion from the study of other more fundamental processes.

In a review published in *Trends in Ecology and Evolution*, C·I·B core team members John Wilson and Dave Richardson, working with Australian collaborators, argued that there is both a practical and theoretical need for a biogeographic definition of biological invasions. However, at the heart of the issue is the need to understand dispersal pathways more generally. While the human-mediated extra-range dispersal of plants is often sufficiently distinct from natural forms of dispersal to warrant a separate classification, it is important to study the fundamental properties of different types of dispersal (Fig. 14).

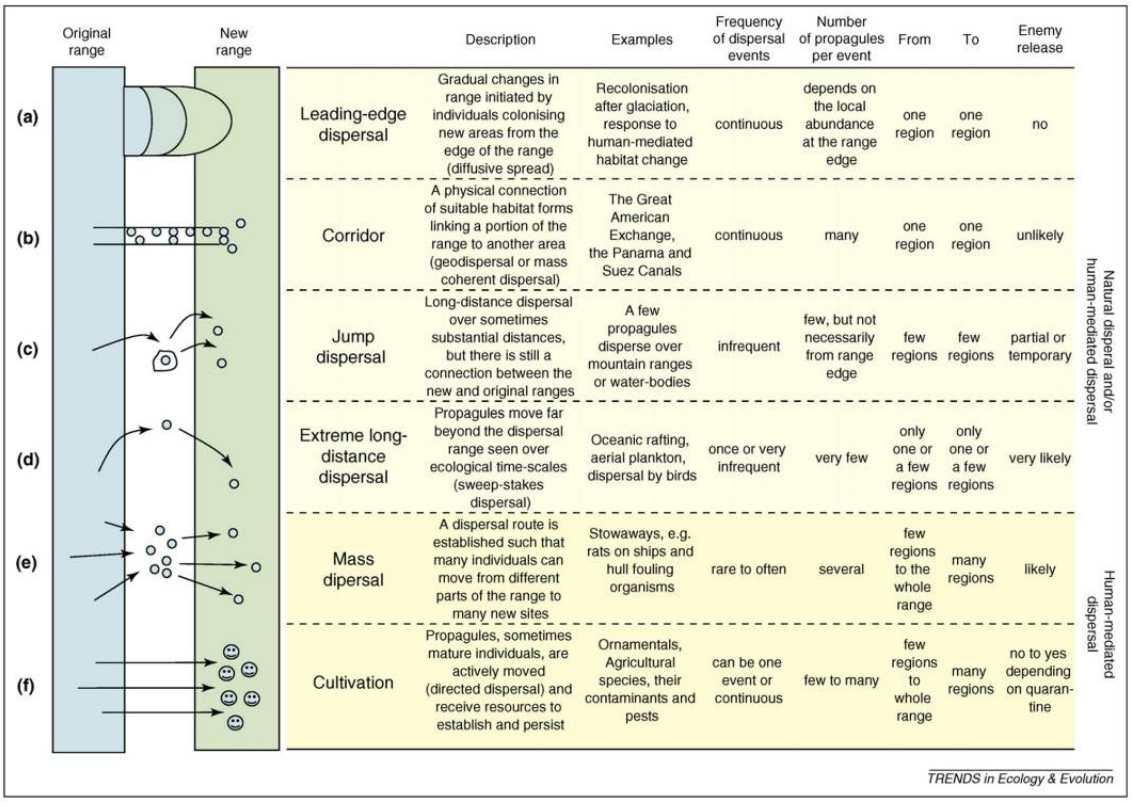

Figure 14. Extra-range dispersal categorised into six types of dispersal pathway. The categories presented are artificially delineated. In most real systems dispersal is probably intermediate between categories or a combination of several categories (Reproduced from Wilson *et al*. 2009; *Trends Ecol. Evol*. **24**, 136-144).

The review presented a framework based on examples of dispersal throughout history, culminating in the observation that molecular studies are increasingly finding that modern

plant invasions are the result of multiple introductions from multiple locations to multiple destinations, such that genetic diversity in the introduced and native ranges is comparable (Wilson *et al.* 2009; *Trends Ecol. Evol.* **24**, 136-144). This framework and the published discussion on this paper (see Wilson *et al.* 2009; *Trends Ecol. Evol.* **24**, 586) provides the rationale for much of the plant invasion work currently underway at the C·I·B, in particular the research on the molecular ecology of invasive plants that is being conducted as part of the joint initiative with the Working for Water Programme.

The evolution of management strategies for fire and invasive plants in Fynbos

C·I·B core team member Brian van Wilgen reviewed the evolution of fire management and related invasive alien plant management policies in Fynbos conservation areas during the 20th century and beyond. Alien pines and hakeas are serotinous trees and shrubs that produce copious numbers of seeds held in cones or follicles. The seeds are released on the death of the parent plants in fires. The seeds are winged, and can spread over great distances after fires. Pines and hakeas are therefore widespread, occurring across the biome. They can and do form dense and impenetrable stands. At the close of the Fynbos Biome Project in 1992, reviews of the fire management of Fynbos ecosystems concluded that prescribed burns, combined with wildfires, firebreak burns in spring, and occasional longer periods between fires would provide sufficient stochasticity to ensure the survival of co-existing species. The same reviews also concluded that dealing with invasive alien plants presented a greater challenge than fires for managers of Fynbos ecosystems. The reviews proposed four scenarios relating to the future of Fynbos ecosystem management, based on different levels of funding (unchanged, increased, decreased and curtailed). They predicted that funding would probably decline, and that invasion would therefore continue largely unchecked. This was especially so in the case of pines, for which no biological control agents were available. In reality, the creation of the Working for Water programme has significantly increased the funding available for invasive alien plant control. However, in the first decade of operations, one estimate in 2007 showed that the programme cleared only 4.5% of the estimated area invaded by pines in South Africa, a rate that will not prevent the spread and eventual domination of pines. An estimate made in 2009 based on the latest available data showed that the Working for Water programme had cleared more than 100% of the pine infestations that were mapped, albeit crudely, in 1994. This suggested that either the crude estimate was hopelessly wrong (as invasive pines are still widespread and dominant), or that they are spreading at a faster rate than they can be cleared. Both are probably true. The termination of research into the biological control of pines (for fear that it may damage the forestry industry) means that the prospect of bringing pine invasions under control has been further reduced. Solving the problem of controlling fire-adapted invasive alien pines in the Fynbos remains the largest challenge to managers concerned with the conservation of Fynbos ecosystems. Failure to address this problem adequately will almost certainly result in the severe degradation of remaining Fynbos ecosystems (Van Wilgen 2009; *S. Afr. J. Sci.* **105**, 335-342).

To move or not to move? Assessing the pros and cons of managed relocation to save species affected by climate change

C·I·B team member Dave Richardson and a group of American scientists, funded by the National Science Foundation and other sources in the USA, developed a new tool for identifying situations when a fairly radical conservation strategy (the deliberate movement of species to new localities to improve their chances of survival) could be seriously considered. Dave Richardson was lead author on a paper that describes the tool that was designed to help policy makers determine when and how to use an environmental strategy known as 'managed relocation.' (Richardson *et al.* 2009; *Proc. Nat. Acad. Sci. U.S.A.* **106**, 9721-9724). The paper debates whether and when it could be feasible to relocate plants, animals and other organisms whose habitats, many of them already compromised by other human-mediated factors such as invasive species, are threatened by rapid climate change.

The tool provides a system for individually scoring a proposed relocation based on key social and ecological criteria. It includes the means for assessing how much is known about the biology, geographical distribution and the ecological uniqueness of the species and the habitat to which it is being moved, how easy the species is to catch, move and propagate, its cultural importance and the financial impact of moving (or not moving) the species. The tool is designed to provide a transparent way to expose the risks, trade-offs and costs involved in using managed relocation — considerations that are often absent from decision-making on natural resources. A butterfly and two tree species in North America were used as examples to illustrate the complex range of issues that need to be considered in such cases.

Managed relocation is only one of several controversial adaptation strategies currently being considered by scientists in the face of mounting threats of global biodiversity. Others include fertilizing the oceans to increase their absorption of greenhouse gases and thereby reduce climate change, conserving migratory corridors that may extend thousands of kilometres, and preserving the genetic diversity of threatened species in seed banks. Research on biological invasions is providing crucial insights to debates about whether to consider any of these new strategies (hence the C·I·B's involvement in this work).

Utilizing citizen scientists – benefits for awareness raising and monitoring

A major success story of the C·I·B's first five years has been the Iimbovane Outreach Project (http://www.sun.ac.za/Iimbovane). This project involves Grade 10 learners in the collection of ant samples from pitfall traps and in the description of vegetation structure close to a large number of schools. The project has been widely lauded for training more than 3000 students from 13 high schools in skills that introduce them to science and environmental issues. In addition, the project is collecting data that will be used to shed light on the composition of ant assemblages across a large part of the country, and the extent and abundance of invasive alien species, such as the Argentine ant (Braschler 2009; *BioScience* **59**, 103-104).

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. Indeed, the large majority of the research undertaken by the Centre takes place via student training at the post-graduate level. 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 support students at 3rd and 4th year, 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 (in all senses) 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.

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

Seventeen students who had been supported by the C·I·B in 2009 or earlier years completed their degrees. These amounted to seven honours/four year B. degree, eight masters, and two Ph.D. degrees. At the 3rd year and 4th year level, 14 students or interns attended the joint C·I·B/Fitzpatrick Institute Biodiversity Conservation Academy. The participants came from six South African higher education institutions, and for the first time, the Academy hosted three SANBI interns. Nine participants were from historically disadvantaged backgrounds. Eight academic and support staff from the two centres, and two volunteers, helped with the management and running of the academy, including the Directors of the two centres. The five-day programme of the Academy immersed students in an intensive series of theoretical, practical and philosophical discussion and field-work sessions on biodiversity conservation, with the aim of improving the participants' appreciation of the complexity of biodiversity, sharpening their knowledge and skills, and broadening their knowledge of the theory and practice of conservation in a South African context. The participants especially enjoyed learning about project planning, design, and presentation skills, and the close interaction and discussions with experienced scientists and peers.

Jennifer Lee, a C·I·B post-doctoral associate, was awarded a prestigious Scientific Committee on Antarctic Research (SCAR) Fellowship for work investigating Antarctic biodiversity, to be undertaken in collaboration with researchers at the British Antarctic Survey. The programme is designed to encourage the active involvement of early career scientists and engineers in Antarctic scientific research, and to strengthen international capacity and cooperation in Antarctic research. Dr. Lee is the first scientist from a South African institution

to receive the award. The funding will facilitate work which uses molecular tools in a phylogeographic approach to investigate the existence of refugia for arthropods in the Antarctic, examining a range of cryptostigmatid mites on the Antarctic Peninsula and the sub-Antarctic island, South Georgia, to understand the genetic structure across populations and the extent to which these organisms exist as metapopulations. By linking molecular data with information on human movement patterns in the region, insight will be gained into the role of humans as vectors for transporting mites and other organisms beyond their natural population ranges. In this way, this research will contribute to our understanding of effective population units and facilitate conservation planning for terrestrial Antarctica.

Former C·I·B masters student Shelley Vosse, and core team members Profs Karen Esler and Dave Richardson were the recipients of the Compton Award for the best paper published in the South African Journal of Botany in 2008. The paper titled *Can riparian seed banks initiate restoration after alien plant invasion? Evidence from the Western Cape, South Africa* (*S. Afr J. Bot.* **74**, 432–444) showed that site history had a large influence on the success of restoration, but that even after heavy infestation, riparian seed banks could contribute to restoration success. Many herbaceous and low shrub elements persisted in the seed bank, but several important riparian species were absent, implying that these species may need to be actively re-introduced.

C·I·B honours student Wilna Jansen was the winner of the Best Student Poster Award at the Congress of the Entomological Society of Southern Africa for her poster titled *The importance of morphological traits among dung beetles in the Maputaland Centre of Endemism.*

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

The C·I·B team contributed 92 peer-reviewed articles to numerous journals, including *PNAS, Proceedings of the Royal Society B, American Naturalist*, *Ecology Letters*, and *Trends in Ecology and Evolution*. The C·I·B, in partnership with award-winning freelance science writer, Leonie Joubert, published the popular book *Invaded. The Biological Invasion of South Africa* (Wits University Press, Johannesburg). Several book chapters were produced for edited scientific texts (for details see Sections 8.1-8.3).

C·I·B members presented five invited or keynote addresses at international meetings and seven at local meetings. Seventy-seven oral presentations were made at scientific meetings (44 international, 33 local), and 31 posters presented (13 international, 18 local). These resulted in 14 published conference proceedings and abstracts.

3.2.2 Scientific communication with students

The C·I·B's Annual Research Meeting was held at the C·I·B hub in Stellenbosch on 27 and 28 November 2009. Twenty-five invited guests from partner institutions attended, along with core team members, staff, post-doctoral associates, and M.Sc. and Ph.D. students of the Centre. In 2009, honours students were also given the opportunity to attend and nine of them took up the invitation.

The student prizes awarded at the Annual Research Meeting continued in 2009, enabling two C·I·B students to travel to a conference or research institution abroad. Anne Treasure (Ph.D. student, Stellenbosch University) won the award for the best poster presentation in the Ph.D. category titled *Synergistic impacts of climate change and invasion on the Prince Edward Islands*. Elsje Kleynhans (M.Sc. student, Stellenbosch University) was awarded the prize for the best presentation in the masters category for her work on *How climate affects tsetse flies: from physiology to distribution modelling*.

3.2.3 Communication with partners

As part of the capacity building thrust of the Memorandum of Agreement with Working for Water, ten WfW and SANParks management staff attended the EMAPI 10 conference held in Stellenbosch in August 2009. The managers participated in introductory discussions on the conference programme, held discussions on research priorities with C·I·B scientists, and participated in the production of a scientific paper on how interactions between scientists and managers could be improved (submitted to a special issue of *Biological Invasions*).

The C·I·B's web site remained the main vehicle for communication with partners, receiving over 15 000 visits during the year. News items ('nuggets') were posted regularly, and a new section highlighting a recent scientific paper of interest to partners and the public was created.

3.2.4 Communication with the public

Iimbovane outreach project

Iimbovane: Exploring South African Biodiversity and Change, is social investment with a difference. This project, launched in 2005, and developed initially with the assistance of the Darwin Initiative and the University of Sheffield, has married educators' requirements to teach biodiversity at secondary school level, with the provision of excellent scientific data to help society better understand South Africa's biodiversity. *Iimbovane* (which means 'ants' in isiXhosa) builds capacity in teachers, while simultaneously empowering, training and providing important life skills to learners in Grade 10 and 11. Nine of the 13 schools currently involved in the project are rurally located, and 12 are located within previously disadvantaged communities, many of which have had little interaction with social investment or educational support programmes. Using ants, Iimbovane teaches learners how to collect, analyse, interpret and present results from a scientific investigation. Regular school visits by the Iimbovane team place scientists in the heart of the community, at the school, where learners feel comfortable asking questions about what it means to study and work in the biological sciences.

In 2008, the Western Cape Education Department requested Iimbovane to expand its work to all secondary schools in the Western Cape Province. The project already had the infrastructure, skills, experience, facilities and staff to commence doing so, and early in 2009 it gained sufficient financial support from Rand Merchant Bank Fund and Anglo American Chairman's Fund to allow expansion to a further five full participation schools and to ten schools on the innovative new subscription system.

A planning meeting between the project team and curriculum advisors from the Western Cape Education Department (WCED) was held in May to discuss the selection of new schools. Five new schools were identified and it was decided that two of the new schools should be located along the West Coast as there are a number of schools that could benefit from supplementary training in the field of biodiversity science, and currently there is no biodiversity outreach programme in place. Schools were selected from three education districts and an additional control site in the West Coast National Park was added to the project (see Table 1).

In June the five new schools were approached and various meetings held with Life Science educators, department heads and school principals. All the identified schools agreed to participate and preparations were made to integrate the new schools with the October 2009 sampling season. This presented the first opportunity for the Iimbovane project team to interact with the learners from the new schools. School visits were very successful, with educators expressing their appreciation for the relevance of the project to the curriculum. At one of the schools (South Peninsula High School) Grade 9 learners also took part in the fieldwork activities, thus gaining a taste of what they can expect should they continue with life sciences in Grade 10. The project team also used this opportunity to invite educators from the five new schools to attend the Iimbovane Implementation Workshop at Stellenbosch University in January 2010.

Figure 15. Iimbovane learners in the classroom (left) and educators at work in the C·I·B laboratory (right).

Apart from the inclusion of five more full participation schools, the project also started to put the Iimbovane subscription system into practice. Once again, WCED curriculum advisors provided support and advice to the project team regarding the selection of schools. It was advised that the subscription schools should be located close to current Iimbovane full participation schools in order to facilitate joint training sessions and to encourage dialogue between the schools. Ten schools were identified and in September the project team met with school staff to disseminate information about the project and to agree on participation. Following the introductory school visits the project team produced the first Iimbovane Starter Kits for handover to subscription schools during the Iimbovane Implementation Workshop (January 2010).

Table 1. Schools added to the Iimbovane Outreach Project in 2009.

School	Town location	EMDC
(a) Full participation schools		
Augsburg Gymnasium	Clanwilliam	West Coast
Diazville Secondary School	Saldanha	West Coast
South Peninsula High School	Diep River, Cape Town	Metropole South
Swartberg Secondary School	Caledon	Overberg
Umyezu Wama Apile Secondary School	Grabouw	Overberg
(b) Sugar Ant (subscription) schools		
Sarepta Secondary School	Kuilsrivier	Metropole East
Malibu Secondary School	Blue Downs	Metropole East
Sibelius Secondary School	Retreat	Metropole South
Lavender Hill Secondary	Lavender Hill	Metropole South
Albert Myburgh Secondary School	Bredasdorp	Overberg
Ravensmead High School	Ravensmead	North
Atlantis High School	Atlantis	North
Breërivier High School	Worcester	Cape Winelands
Luckhoff High School	Stellenbosch	Cape Winelands
Vredendal Secondary School	Vredendal	West Coast

In addition to the activities related to the expansion of Iimbovane, the project continued with its outreach visits to the original 13 schools and associated control sites. These schools were visited in March and October to complete the biannual sampling for 2009. Learners from four of the schools were able to assist the team with sampling at the control sites. During August the project team undertook a data handover trip to share the data collected by the learners during the March 2009 sampling event among the Iimbovane schools.

Scientific outputs from the project include two scientific papers, one in *BioScience* and one in *Journal of Insect Conservation*. The paper published in *BioScience* received additional coverage in a blog discussion of citizen science (http://pretendbiologist.blogspot.com /2009/08/citizen-science-research-and-education.html).

As the major vehicle for outreach at the C·I·B, the Iimbovane outreach project was involved in a number of outreach initiatives and youth symposia. In May Iimbovane coordinated and participated in the annual 'Take a Girl Child to Work Day', an initiative that aims to inspire young women to make informed career choices. The participation in this event was well received by the four learners from Swartberg Secondary School who visited the C·I·B. Members of the Iimbovane team participated as judges in the regional finals of the Eskom for Young Scientists in August 2009. The organisers of the Global Environmental Teaching (GET) programme approached Iimbovane to act as one of the host partners during the 2009 GET programme visit to South Africa. GET members were extremely impressed with the project, especially with the combination of a working outreach project with active science activities. Iimbovane also maintained its involvement with the further training of Life Science educators on biodiversity conservation, through lecturing biodiversity and ecology modules for the Advanced Certificate in Education course, a part time course offered by the Department of Education (Stellenbosch University).

The project continued to enjoy a high public profile through its presence in a variety of print media, broadcast media, and online web resources. The funding award from Rand Merchant Bank Fund was widely promoted and featured in various local newspapers, online news feeds and in publications circulated by the Stellenbosch University (see Sections 8.7-8.8). The contribution of secondary school learners to science projects was highlighted in an article in a community newspaper (*Vukani*, 29 October 2009). The article called attention to the role that Luhlaza Secondary School learners played in data collection for the *Journal of Insect Conservation* paper. A further media highlight was the inclusion of the project on the television show, *Bush Buzz*, a youth environmental education programme. The episode focused on biodiversity and Iimbovane was featured for its role in educating the youth about biodiversity conservation and ecological issues.

In terms of radio broadcasting, the project received coverage on an environmental programme, EkoForum, on Radio Sonder Grense. This insert included an interview with the Centre's Outreach Manager, Ms. Dorette du Plessis, on the significance and growth of the project since its first introduction to the public. Communication about the project took place at a number of community conservation forums; for example, Ms. Du Plessis was invited to

speak about the project's activities at Tygerberg Nature Reserve and Karoo National Park, two protected areas in which the Iimbovane team monitors ant diversity.

Media highlights

C·I·B researchers received much media attention during the past 12 months, including a number of newspaper articles, contributions to popular science publications, invited talks and interviews on radio and television (see Section 8.9).

Steven Chown's receipt of the Martha Muse T. Award, for contributions to Science and Policy in Antarctica, was widely reported both in the local and international media. Dave Richardson's involvement in the Managed Relocation Working Group received a much attention following the publication in the influential *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* of a decision-support tool to assist managers and decision-makers when implementing 'assisted migration' (the practice of deliberately translocating plants or animals to a new location, often in response to threats in the original habitat and with the aim of increasing their prospects of survival). The publication led to several articles in the local newspapers and stimulated discussion in the agriculture magazines *Farmer's Weekly* and *Landbouweekblad* and on international websites. Dave was also recognised for his valuable research contributions at the annual NSTF Award ceremony where he received the award for 'research and its outputs over the last five years or less'. This achievement generated a wide range of media interest with articles published in *Eikestadnuus, Cape Argus, Business Report* and *Echo de Aar*.

C·I·B associate Leonie Joubert added considerably to the C·I·B's public profile when she was awarded the SAB Environmental Journalist of the Year 2009 Award for her popular science work, *Invaded. The Biological Invasion of South Africa.* Popular articles about this achievement were published in *Landbouweekblad, Farmer's Weekly, Environmental Management* and *Fishing Industry News*. Various local newspapers (e.g. *District Mail* and *Paarl Post*) also reported on this achievement, and Ms. Joubert was interviewed by John Maytham on 567 Cape Talk radio.

In addition to the print and online media resources, the C·I·B also raised its media profile through a number of interviews on radio. Jaco Le Roux was interviewed on Radio Sonder Grense's topical discussion programme, *Spektrum* concerning the current and projected extent of invasive species and their impacts on South Africa's 'green capital'. In the interview, Jaco placed South Africa's situation in a global context and he described the current management actions of the South African government aimed at preventing and controlling invasive alien species. He also highlighted the achievements of the Working for Water programme.

3.2.5 Knowledge Management System

The C·I·B Information Retrieval and Submission System (IRSS) continued to develop as an increasing volume of information was submitted. Thirty-seven theses and datasets were

submitted, as well as 77 long term datasets originating from the C·I·B's long term monitoring transects. In addition, 265 publications were lodged in the system.

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

Existing formal agreements with research and other organizations were maintained, including with: CapeNature, Iziko Museums of Cape Town, The Centre for Advanced Studies in Ecology and Biodiversity (Chile), Institute for Biological Invasions (U.S.), British Antarctic Survey (BAS, U.K.), South African Institute for Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). In addition, agreements were concluded with key individuals through the Research Associate scheme. During 2009, John Cooper (consultant, formerly of the Animal Demography Unit, University of Cape Town) and Mark Robertson (Department of Zoology and Entomology, University of Pretoria) became Research Associates of the Centre.

A new Memorandum of Understanding was entered into with the Applied Biodiversity Research Division of SANBI. The purpose of the MOU is to strengthen the interaction between SANBI and the C·I·B through both the implementation of short-term research partnerships and contracts, and the appointment of a joint SANBI/C·I·B Invasive Species Scientist. John Wilson was appointed to the position in May 2009. Dr. Wilson works closely with the Early Detection and Rapid Response (EDRR) Programme of SANBI to lead and develop a programme of research on invasive species for SANBI, in collaboration with the C·I·B.

An extension to the five-year WfW Memorandum of Agreement allowed the establishment of a project on ecological restoration following *Eucalyptus* invasion and clearing. This project will support the work of a post-doctoral associate and two Ph.D. students in 2010.

In addition, substantial support was provided by the C·I·B to improve collaboration among C·I·B partners in the long term monitoring of biodiversity in South Africa's mountain ranges. Funding was provided to researchers at the Universities of Pretoria and Venda to support the creation of a technical post in Pretoria to help with the sorting of material, and to establish a transect in the Soutpansberg over the next three years. Susana Clusella-Trullas

represented the C·I·B at an international consortium meeting of researchers investigating biodiversity change on mountains.

During the reporting year, short-term contracts were signed with SANBI for contributions to South Africa's Second National Communication to the United Nations Framework Convention on Climate Change, with the Flower Valley Conservation Trust, and with Cape Action for People and the Environment. This work is ongoing.

4.2.2 New international agreements

None

4.2.3 New national agreements

SANBI, Applied Biodiversity Research Division

Working for Water – extension to 2008 Memorandum of Agreement

University of Pretoria, Department of Zoology and Entomology (Prof. Berndt van Rensburg)

University of Venda, Department of Zoology (Dr. Stefan Foord)

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

Prof. Spencer Barrett, Department of Ecology and Evolutionary Biology, University of Toronto, Canada *Contributor to invasion ecology book* (Richardson)

Prof. J. Bengtsson, Swedish Agricultural University, September 2009. *Collaborator on SA-Sweden grant* (Chown)

Dr. Harry Biggs, Scientific Services, SANParks (van Wilgen)

Prof. Mark Burgman, Australian Centre of Excellence for Risk Analysis, University of Melbourne, Australia *Collaborator on studies on risk assessment in invasive species* (Richardson)

Prof. Pilar Castro, Dpto. Ecología, Facultad de Ciencias Universidad de Alcalá Ctra. Madrid, Spain *Collaboration on study of invasiveness in Australian acacias* (Richardson)

Drs Louis Deharveng and Anne Bedos, Museum National d'Histoire Naturelle, Origine, Structure et Evolution de la Biodiversité *Collaborator on documenting soil faunal biodiversity in the Cape Floristic Region, with specific emphasis on Collembola. This project forms part of a larger collaborative SA/France, SA/Norway, SA/Sweden project* (van Vuuren).

Mr. Andres Fuentes and Ms. Barbara Langdon, Universidad de Concepción-CHILE *Collaboration on early detection and rapid response of alien plant invaders* (Wilson).

Dr. Markus Gusset, Wildlife Conservation Research Unit, University of Oxford, *Collaborator on the carnivore reintroduction programme* (Somers)

Dr. Richard Hecker, Manager, CSIRO Journal Publishing, Canberra, Australia (van Wilgen)

Dr. Anna Jacobsen, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311-1099 (Esler)

Dr. Jesse Kalwij, Senior Research Fellow, Institute of Ecology and Earth Science, Estonia. *Collaborator on alien plant distributions in the Drakensberg* (van Rensburg)

Prof. H.P. Leinaas, University of Oslo, Norway, September 2009. *Collaborator on SA-Norway grant* (Chown)

Dr. David Mbora, Professor of Biological Sciences, Dartmouth College, USA. *Collaborator on dung beetle research conducted in Tembe Elephant Park to examine morphological characters in dung beetles related to habitat change* (van Rensburg)

Dr. Ara Monadjem, Department of Biological Sciences, University of Swaziland. *Collaborator on Rattus systematics and biogeography, and its associated diseases* (Chimimba)

Dr. Martin Nunez, Department of Ecology and Evolution, University of Tennessee *Collaborator on studies of invasive pines worldwice* (Richardson)

Profs Ben Oldroyd and Madeleine Beekman, School of Biological Sciences, University of Sydney, Australia. *Collaborator on reproductive dynamics and social parasitism in the Cape honeybee* (Wossler).

Dr. Kate Parr, Research fellow in African ecology, Centre for the Environment, Oxford University, UK. *Collaborator on the effects of Chromolaena odorata programme* (Somers)

Dr. Kate Parr, Research fellow in African ecology, Centre for the Environment, Oxford University, UK. *Collaborator on projects related to ants in the Sani Pass, Drakensberg and Tembe Elephant Park* (van Rensburg)

Dr. Brandon Pratt, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311-1099 (Esler)

Prof. Marcel Rejmanek, Section of Ecology and Evolution, University of California, Davis, USA *Collaborator on studies on tree invasions* (Richardson)

Dr. Frank Schurr, Plant Ecology and Nature Conservation, University of Potsdam, Maulbeerallee 3, 14469 Potsdam, Germany (Esler)

Dr. Brent Sinclair, University of Western Ontario, Canada, April 2009. *Collaborator on SANAP grant* (Chown)

Ms. Lauren Urgenson, Ph.D. Candidate in Restoration Ecology and NSF Integrated Graduate Education and Research Training (IGERT) Fellow, College of Forest Resources, University of Washington, Seattle. *Collaborator on a multi-stakeholder assessment of incentives and barriers to invasive plant management in the Western Cape* (Prozesky)

4.2.5 Academic visits by core team members to other institutions

Australian Antarctic Division, Australia. *International Polar Year collaboration with Dr. D.M. Bergstrom* (Chown)

Australian Centre for Evolutionary Biology and Biodiversity, School of Earth and Environmental Sciences, University of Adelaide, Australia. *Collaboration on research dealing with adaptive evolution in invasive species* (Richardson)

Australian Wildlife Conservancy, Wentworth and Scotia Sanctuary, Australia. *Collaboration on effects of the reintroduction of marsupials on biodiversity with Dr. Matt Hayward* (Somers)

Bio-Protection Research Centre, Lincoln University, New Zealand. *Meetings with Prof. Alison Stewart (Director), staff and students on issues relating to biosecurity and invasion ecology* (Richardson)

Center for Advanced Studies in Ecology and Biodiversity (CASEB), Catholic University of Chile, Chile. *Member of International Review Panel and meetings with Prof. Fabian Jaksic (Director) on areas for potential collaboration* (Richardson)

Centre for Functional Ecology, Department of Botany, University of Coimbra, Portugal. *Meetings with Prof. Helena Freitas (Director), staff and students on issues relating to plant invasion ecology, especially relating to invasive Australian acacias* (Richardson)

Invasion Ecology and Biological Control Lab, Wuhan Botanical Garden, Chinese Academy of Sciences, Wuhan, Hubei Province, China. *Study on alligator weed and other alien plants.* (Wilson)

Laboratorio de Invasiones Biológicas, Facultad de Ciencias Forestales, Universidad de Concepción, Chile. *Collaborator as co-editor of special issue of journal with Prof. Aníbal Pauchard* (Richardson)

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

Philips-University Marburg, Marburg, Germany. *Collaboration on habitat fragmentation research with Sascha Rösner, Manfred Keil, Peter Poschlod; Christoph Reisch, Frank Schurr; Cornelia Krug* (Esler)

Royal Botanical Garden, Kew, London. *Post-doc Dr. Justine Shaw was hosted by Dr. Martin Hamilton* (Chown)

School of Environmental Sciences, Braunschweig University. *Guest Lecture.* (Samways)

School of Geography and the Environment, Oxford University. *Collaboration with Prof. R.J. Whittaker on a special issue of Diversity and Distributions dealing with conservation biogeography* (Richardson)

The Commonwealth Scientific and Industrial Research Organisation, Atherton, Australia. *Global molecular ecology of* Miconia calvescens *with Dr. Denise Hardesty.* (Le Roux)

University of Adelaide, Adelaide, Australia. *Mini weeds workshop: Adaptation and lagphase dynamics with Prof. Andrew Lowe.* (Le Roux)

University of Melbourne, Australia. *Collaboration with Prof. A.A. Hoffmann* (Chown).

University of Oslo, Norway. *Collaboration with Prof. H.P. Leinaas* (Chown).

4.2.6 Research collaborations

Acclimation effects in provision of ecosystem services. Collaborator: EU/RUBICODE. (Samways)

Adaptive ecosystem management in South African National Parks. Collaborator: Dr. Harry Biggs, Scientific Services, SANParks Skukuza (van Wilgen)

Adaptive evolution in invasive species. Collaborators: Prof. Andy Lowe, Australian Centre for Evolutionary Biology and Biodiversity, School of Earth and Environmental Sciences, University of Adelaide, Australia (Richardson)

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

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

Biodiversity indicators. Collaborator: Dr. Stuart Butchart, BirdLife International, Wellbrook Court, Girton Road, Cambridge CB30NA, U.K. (McGeoch)

Biodiversity value and conservation importance of ecological transition zones, 2006 – present. Collaborator: Dr. Salit Kark, The Biodiversity Research Group, Dept. of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, Israel (van Rensburg)

Biogeography and cytosystematics of Malagasy bats: Collaborator: Dr. PJ Taylor, Ms. Leigh Richards, University of KwaZulu-Natal; Steven Goodman, Field Museum of Natural History Chicago (Rambau)

Bio-geomorphology and climate change impacts in the sub-Antarctic. Collaborator: Prof. Jan Boelhouwers, Department of Earth Sciences, Uppsala University, Sweden (McGeoch)

BTB/buffalo/helminth interactions in Hluhluwe-iMfolozi Park. Collaborators: Anna Jolles, Oregon State University; Vanessa Ezenwa, Princeton University; Sue van Rensburg, Ezemvelo KZN Wildlife (Somers)

Building a social science platform for Antarctic research. Collaborators: Mr. John Cooper, Animal Demography Unit, University of Cape Town; Prof. Sandra S. Swart, Department of History, Stellenbosch University (Chown, Prozesky)

Carnivore reintroduction biology and effects on biodiversity, 2004-2009. 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)

Chromolaena odorata and biodiversity in Hluhluwe-iMfolozi Park, 2005-2009. Collaborators: Ansie Dippenaar-Schoeman, Agricultural Research Council; Sue van Rensburg, Ezemvelo KZN Wildlife; Alan Anderson, CSIRO, Australia, Kate Parr, Oxford University (Somers).

Conifer invasions in the southern hemisphere. Collaborator: Prof. D. Simberloff, Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, USA (Richardson)

Design of ecological networks. Collaborator: Mondi (Samways)

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

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

Early detection and rapid response. Collaborators: Mr. Philip Ivey, Dr. Barbara Mahsope, Ms. Ernita van Wyk, SANBI; Mr. Llewellyn Jacobs CAPE Nature; Mr. Carlo de Kok. (Wilson)

Ecology of insect herbivore systems. Collaborator: Dr. Nigel Andrew, School of Environmental Sciences and Natural Resource Management, University of New England, Australia (McGeoch).

Ecology of plant invasions - various studies. Collaborators: Profs. Vojtěch Jarošík, Petr Pyšek and Jan Suda; Institute of Botany, Department of Invasion Ecology, Academy of Sciences of the Czech Republic, Průhonice, CZ 252 43, Czech Republic (Richardson)

Effects of ungulates on spider diversity in Hluhluwe-iMfolozi Park, 2005-209. Collaborators: William Bond, University of Cape Town; Ansie Dippenaar-Schoeman, Agricultural Research Council; Sue van Rensburg, Ezemvelo KZN Wildlife; Alan Anderson, CSIRO Australia (Somers)

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

Evolution of altruism. Collaborator: Dr. A. Ouhinou, African Institute of Mathematical Sciences (Hui)

Fire and invasive alien plant ecology and management of the Tsitsikamma area (Proposed Garden Route National Park). Collaborators: Prof. Richard Cowling, Nelson Mandela Metropolitan University; Tineke Kraaij, South African National Parks (van Wilgen)

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

Genetic diversity of *Echium plantagineum* populations in Western Cape. Collaborator: Dr. Barbara Rudolph, Universität Hamburg, Bio-Zentrum Klein-Flottbek, Ohnhorststraße 18, D-22609 Hamburg, Germany (Esler)

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

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

Island resoration. Collaborator: Cousine Island Trust. (Samways)

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

Large-scale ecosystem effects. Collaborator: EU/ALARM. (Samways)

Larval feeding regimes and success of social parasitism in honeybees. 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)

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, UK (2005 – present; Dr. Jesse Kalwij, Senior Research Fellow, Institute of Ecology and Earth Science, Estonia (207-present) (van Rensburg)

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

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

Molecular ecology of plant invasions. Collaborators: Prof. Andy Lowe, Ms. Eleanor Dormontt, Adelaide University; Dr. Peter Prentis, University of Queensland (Richardson, Wilson)

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

Multidimensional evaluation of managed relocation. Collaborator: Prof. J. Hellmann, Department of Biological Sciences, University of Notre Dame, IN, USA (Richardson)

Overall 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)

Phylogenetic patterns in plant invasions. Collaborator: Dr. Şerban Procheş, University of KwaZulu-Natal (Richardson, Wilson)

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

Phylogeography and ecology of the Otomyinae. Collaborator: Dr. PJ Taylor, Curator Durban Natural Science Museum (Rambau)

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

Predicting invasiveness of Australian *Acacia* species. Collaborators: Drs P. Castro- Díez, O. Godoy and A Saldaña, Departamento de Ecología, Universidad de Alcalá, Madrid, Spain. (Richardson)

Relative genome size: a predictor of hybrid fertility in horticultural important plants. Collaborator: Dr. Jan Suda, Department of Botany, Faculty of Science, Charles University in Prague, Czech Republic and Institute of Botany, Academy of Sciences of the Czech Republic, Czech Republic (Le Roux, Richardson, Wilson)

Research into 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; Dean Impson, Cape Nature (Griffiths)

Research on 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)

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

Restoration of degraded renosterveld. Collaborator: Dr. Peter Poschlod. University of Regensberg, Germany (Esler)

Restoration of natural capital. Collaborator: Prof. James Blignaut. ASSET, Jabenzi, Beatus and Department of Economics, University of Pretoria; Prof. Sue Milton. RENU KAROO, Prince Albert; Dr. David Le Maitre. CSIR, Environmentek, PO Box 320, Stellenbosch 7599; Sean Privett, Flower Valley Conservation Trust (Esler)

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

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)

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)

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

Spatial pattern formation of a predator-prey system. Collaborator: Dr. S. C. Oukouomi Noutchie, Department of Mathematical Sciences, Stellenbosch University (Hui)

The 'knowing-doing' gap in invasion biology. Collaborator: Dr. Gyan P. Sharma, previously Department of Conservation Ecology and Entomology, Stellenbosch University (Esler, McGeoch, Prozesky)

The biodiversity implications of South Africa's biofuels strategy. Collaborators: Drs Patrick O'Farrel and Graham von Maltitz, CSIR, Natural Resources and Environment, South Africa (Richardson)

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

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

Core team members and post-doctoral associates continued to provide scientific services, both domestically and abroad, in the form of editorial support and reviews for journals, reviews for granting agencies, assistance to the NRF, board memberships and committee work for various organizations.

5.2.1 National panels and committees

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

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

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

Council of the South African Association of Botanists: Vice-President (Esler)

Fynbos Forum Committee: Member (Esler)

Green Trust, Board of Trustees: Member (Chimimba)

Helderberg Nature Reserve Advisory Board: member (Wossler)

HERS (Higher Education Resource Systems) Advisory Board: Member (Esler)

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

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

National Science and Technology Forum (NSTF) and the Scientific, Engineering and Technological Societies and Allied Professions Group of South Africa (SETAG): [homepage: http://www.nstf.org.za/]: Member (van Rensburg)

Organizing Committee for SAAB 2009 Meeting, 2009: Chair (Esler)

Paarl Mountain Advisory Board: Member (Esler)

Prince Edward Islands Management Committee. Member (Chown)

SEAChange Advisory Panel: Member (Griffiths, Samways)

South African Association of Women in Science and Engineering, Western Cape Branch: Treasurer (Esler)

South African Biota Liaison Committee: member (Esler)

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

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

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

Working for Water Programme, Research Advisory Panel: Member (van Wilgen)

Zoological Society of Southern Africa – Biodiversity portfolio [ZSSA homepage: http://www.zssa.co.za/]: Council Member (van Rensburg).

5.2.2 International panels and committees

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

British Ecological Society Overseas Bursary Panel: Member (Chown)

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

Center for Advanced Studies in Ecology and Biodiversity, Chile: International Advisory Board Member (alternate for S.L. Chown in 2009) (Richardson)

Executive committee of MEDECOS Association, ISOMED: Member (Esler)

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

International panel convened to undertake a formal science review of the National Centre for Advanced Bio-Protection Technologies, Lincoln University, New Zealand, November 2009: Member (Richardson)

International Union for the Study of Social Insects congress, Copenhagen, Denmark 2010: Programme Committee Member (Wossler)

IUCN Species Survival Specialist Group on conifers: Member (Richardson)

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

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

IUCN/SSC: Steering Committee: Member (Samways)

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

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

IUCN-SSC Re-introduction specialist Group: Member (Somers)

Local organising committee for International Conference on Alien Plant Invasions (EMAPI 10): Chair (Richardson); Members (Esler, Le Roux, Wilson)

Local Organizing Committee for DIVERSITAS OSC2, 2009: Member (Esler)

Orthopterists' Society: President-Elect (Samways)

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

Xerces Society: Counselor (Samways)

5.2.3 Editorial and refereeing activities

Editor

International

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

Contemporary Conservation Science Series, Wiley-Blackwell (Samways)

Journal of Biogeography, Co-Editor (McGeoch)

National

African Zoology, Co-Editor (Griffiths)

South African Journal of Wildlife Research, Editor-in-Chief (Somers)

Associate Editor

International

American Naturalist (Chown)
Biodiversity and Conservation (Chimimba)
Biological Invasions (Hui, Le Roux, Richardson)
Conservation Biology (Somers)
Diversity and Distributions (Wilson)
International Journal of Wildland Fire (van Wilgen)
Journal of Insect Conservation (Samways)
Marine Biology (Griffiths)
Plos ONE (Somers)
Polar Biology (Chown)

National

None

Editorial Boards

International

African Journal of Ecology (Somers)
Antarctic Science (Chown)
Austral Ecology (McGeoch)
Conservation Biology (Samways)
Conservation Science and Practice (Samways)
Environmental Management (Richardson)
Functional Ecology (Chown)
International Journal of Wildland Fire (van Wilgen)
Journal of Orthoptera Research (Samways)
Myrmecological News (Samways)
Odonatologica (Samways)
Proceedings of the Royal Society B (Chown)
The Open Zoology Journal (Hui)

National

African Entomology (Wossler)
African Natural History (Griffiths)
Koedoe (Griffiths)
Navorsinge van die Nasionale Museum, Bloemfontein (Chimimba)
Smithiana (Griffiths)
South African Journal of Science (van Wilgen)

5.2.4 Reviewing

International

Acta Oecologica; Acta Theriologica; Acta Zoologica lituanica; African Journal of Biotechnology; African Journal of Ecology; American Naturalist; Annals of Botany; Antarctic Science; Applied Soil Ecology; Aquatic Biology; Aquatic Living Resources; Australian Journal of Botany; Biodiversity and Conservation; Biological Control; Biological Invasions; Biological Reviews; BMC Evolutionary Biology; Conservation Biology; Current Zoology; Diversity and Distributions; Ecography; Ecological Applications; Ecological Entomology; Ecological Modelling; Ecological Restoration; Ecology; Ecology and Society; Ecology Letters; Ecosystems; Environmental Entomology; Environmental Management; Forest Ecology; Forest Ecology and Management; Functional Ecology; Global Ecology and Biogeography; Insect Diversity and Conservation; International Journal of Wildland Fire; Journal of Applied Ecology; Journal of Arid Environments; Journal of Biogeography; Journal of Comparative Physiology B; Journal of Ecology; Journal of Evolutionary Biology; Journal of Experimental Biology; Journal of Insect Conservation; Journal of Insect Physiology; Journal of Morphology; Journal of Theoretical Biology; Journal of Thermal Biology; Journal of Zoology; Landscape Ecology; Mammalian Species; Marine Biology; Molecular Ecology; New Phytologist; New Zealand Journal of Botany; Oecologia; Perspectives in Plant Ecology, Evolution and Systematics; Physiological Entomology; Plant and Soil; Plant Biology; Plant Ecology; PNAS; Proceedings of the Royal Society B; Restoration Ecology; Revista de Biologia Tropical; Science; The Open Zoology Journal; Trends in Ecology and Evolution; Weed Research; Zoologia; Zoosystematics and Evolution; ZooTaxa

National

African Entomology; African Journal of Aquatic Sciences; African Journal of Marine Science; African Natural History; African Zoology; Bothalia; Koedoe: African Protected Area Conservation; South African Journal of Botany; South African Journal of Science; South African Journal of Wildlife Research

Grant reviews for external bodies

Czech Science Foundation (Esler)

Czech Science Foundation, Project proposal (Wilson)

Grant review from Czech Science Foundation, Grantova agenture Ceske republiky (Clusella-Trullas)

Leverhulme Trust Research Project Grant (x 2) (Chown)

National Geographic Committee for Research and Exploration, Grant application (van Vuuren)

Water Research Commission (Esler)

Appointment reviews and committees

Charles Darwin University, NT, Australia: professorial appointment (Richardson)
Macquarie University, N.S.W., Australia: professorial appointment (Richardson)
University of Pretoria: professorial appointment (Richardson)

Conferences/workshops organized

The 10th international conference in the Ecology and Management of Plant Invasions (EMAPI 10) was hosted by the C·I·B (Dave Richardson) in August 2009. The conference, which took place at Spier Estate, Stellenbosch, was attended by 263 delegates form South Africa and abroad, including many C·I·B students and other international students.

Consulting and other services rendered

Chown, S.L. (Ed.). 2009. *Biological prospecting in the Antarctic: An update on the review by SCAR*. Working Paper prepared for SCAR to the XXXII Antarctic Treaty Consultative Meeting, Baltimore, 2 pp.

Lee, J.E. & Chown, S.L. (Ed.). 2009. *Propagule transport associated with logistic operations: a South African appraisal of a regional issue*. Working Paper prepared for South Africa for submission to the XXXII Antarctic Treaty Consultative Meeting, Baltimore, 8 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).

Wilson, J.R.U. Course: An introduction to R as a tool for statistical analysis: Wuhan Botanical Gardens / Chinese Academy of Sciences, Wuhan, China (2009), Stellenbosch University, South Africa (2009).

6 Gender impact of research

Gender equity continues to form a major theme underlying the C·I·B's activities. Thus, seven of the Centre's 22 core team members are women, eight of its thirteen post-doctoral associates are women, 20 of its 24 hub staff are women, and women constitute 54 % of the student body supported by the C·I·B. The C·I·B's outreach work and long-term projects are run by women, who are, without exception, remarkable role models showing what can be achieved by women in science. Centre members continue to promote gender equity through activities such as SA-WISE, HERS-SA, and 'Take a Girl Child to Work' day. Typically, the Centre's research *per se* is not concerned with gender equity, although the South African National Antarctic Programme Legacy project is providing information for social sciences work in this area, and is investigating aspects thereof itself.

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. Dave Richardson	South Africa	SU	M	W	100
Ms. Sarah Davies	South Africa	SU	F	W	100
Prof. Chris Chimimba	South Africa	UP	M	B	10
Dr. Susana Clusella-Trullas	Spain	SU	F	W	100
Prof. Karen Esler	South Africa	SU	F	W	30
Dr. Stefan Foord	South Africa	UNIVEN	M	W	20
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	10
Dr. Jaco le Roux	South Africa	SU	M	W	100
Prof. Melodie McGeoch	South Africa	SANParks	F	W	20
Dr. Augustine Niba	Cameroon	WSU	M	B	10
Dr. Heidi Prozesky	South Africa	SU	F	W	10
Dr. Victor Rambau	South Africa	SU	M	B	10
Prof. Michael Samways	South Africa	SU	M	W	20
Prof. Michael Somers	South Africa	UP	M	W	20
Prof. Berndt van Rensburg	South Africa	UP	M	W	40
Prof. Bettine van Vuuren	South Africa	SU	F	W	10
Dr. Brian van Wilgen	South Africa	CSIR	M	W	10
Dr. John Wilson	South Africa	SU	M	W	75
Prof. Theresa Wossler	South Africa	SU	F	W	10

7.2 Post-doctoral associates

Full name	Citizenship	Institution	Race	Gender	Time spent working in CoE (%)
Dr. Adeline Barnaud	France	SU	W	F	80
Dr. Brigitte Braschler	UK	SU	W	F	100
Dr. Alana den Breeyen	South Africa	SU	W	F	100
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. Donald Midoko-Iponga	Gabon	SU	B	M	50
Dr. Marc Rius	Spain	UCT	W	M	100
Dr. Justine Shaw	Australia	SU	W	F	100
Dr. Dian Spear	UK	SU	W	F	100
Dr. Feng Zhang	China	SU	B	M	40

7.3 Students supported in 2009

Name	Citizenship	Institution	Race	Gender	Status
Honours/4 year B. degree					
Ms. Lisa Isaacs	South Africa	UP	B	F	Completed
Ms. Andiswa Jafta	South Africa	WSU	B	F	Awaiting final marks
Ms. Wilna Jansen	South Africa	UP	W	F	Completed
Mr. Sebata Mafereka	South Africa	WSU	B	M	Awaiting final marks
Mr. Dickson Mazibuko	Malawi	SU	B	M	Completed
Mr. Musa Ngalwa	South Africa	WSU	B	M	Awaiting final marks
Mr. Matthys Strydom	South Africa	SU	W	M	Completed
Mr. Allen Tshautshau	South Africa	UniVen	B	M	Completed
Mr. Herbert van Zyl	South Africa	SU	W	M	Completed
Ms. Inam Yekwayo	South Africa	WSU	B	F	Awaiting final marks
Mr. Martijn van der Merwe	South Africa	SU	B	M	Completed
Ms. Linke Potgieter	South Africa	SU	W	M	Completed
Masters					
Mr. Casparus Crous	South Africa	SU	W	M	Completed
Ms. Michelle Gibson	USA	SU	W	F	Continuing
Mr. Anton Hough	South Africa	SU	W	M	Continuing
Ms. Elsje Kleynhans	South Africa	SU	W	F	Continuing
Ms. Manqhai Kraai	South Africa	NMMU	B	F	Completed
Mr. Mohlamatsane Macdonald Mokhatla	South Africa	UP	B	M	Continuing
Mr. Fulufhelo Mukhadi	South Africa	SU	B	M	Continuing
Mr. Caswell Munyai	South Africa	UniVen	B	M	Continuing
Mr. Thabisisani Ndhlovu	Zimbabwe	SU	B	M	Continuing
Ms. Tantsi Nolubabalo	South Africa	UP	B	F	Continuing
Ms. Megan Nowell	South Africa	SU	W	F	Continuing
Ms. Jean Purdon	South Africa	UP	W	F	Pending
Ms. Tondani Madeleine Ramantswana	South Africa	SU	B	F	Continuing
Mr. Tshililo Ramaswiela	South Africa	SU	B	M	Continuing
Mr. Andrew Rogers	USA	SU	W	M	Continuing
Ms. Genevieve Thompson	South Africa	SU	W	F	Continuing
Ms. Martina Treurnicht	South Africa	SU	W	F	Continuing
Ms. Lize-Marie van der Watt	South Africa	SU	W	F	Continuing
Ms. Carlien Vorster	South Africa	SU	W	F	Continuing
Ms. René Wolmarans	South Africa	UP	W	F	Completed
M.Sc.-Ph.D. upgrade					
Mr. James Rodger	South Africa	UKZN	W	M	Continuing
Ms. Nicola van Wilgen	South Africa	SU	W	F	Continuing

Ph.D.					
Mr. Ryan Blanchard	South Africa	SU	B	M	Continuing
Mr. Bernard Coetzee	South Africa	SU	W	M	Continuing
Ms. René Gaigher	South Africa	SU	W	F	Continuing
Ms. Tanya Haupt	South Africa	SU	B	F	Continuing
Ms. Sanet Hugo	South Africa	UP	W	F	Continuing
Ms. Charlene Janion	South Africa	SU	W	F	Continuing
Ms. Candice Lyons	South Africa	SU	W	F	Continuing
Mr. Greg McClelland	Canada	SU	W	M	Continuing
Ms. Natasha Palesa Mothapo	South Africa	SU	B	F	Continuing
Mr. James Mugabe	Zimbabwe	SU	B	M	Continuing
Ms. Joice Ndlovu	Zimbabwe	SU	B	F	Continuing
Ms. Ethel Phiri	South Africa	SU	B	F	Continuing
Ms. Ulli Poonan	South Africa	Wits	B	F	Pending
Mr. Jeremy Shelton	South Africa	SU	W	M	Continuing
Ms. Anne Treasure	South Africa	SU	W	F	Continuing
Ms. Charmaine Uys	South Africa	UCT	W	F	Continuing
Mr. Tsungai Zengeya	Zimbabwe	UP	B	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
Dr. Jaco le Roux	SU	Molecular Laboratory Manager	W	M
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	B	M

Name	Inst.	Position	Race	Gender
		Management		
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	Organisation
Ms. Nobubele Boniwe	Hons	Dr. A.S. Niba	Department of Water and Environmental Affairs
Dr. Lukeshni Chetty	Ph.D.	Prof. C. Viljoen*	SANBI
Dr. Susana Clusella-Trullas	Post-doc	Prof. S.L. Chown	C·I·B
Mr. Kyle Harris	M.Sc.	Prof. B.J. van Rensburg	Environmental consultancy
Dr. John Wilson	Post-doc	Prof. D.M. Richardson	SANBI / C·I·B

* open bursary programme

8 Outputs

8.1 Books

Hayward, M.W. & Somers, M. (Eds.) (2009) *Reintroduction of Top-order Predators*. Wiley-Blackwell, Oxford, London, 459 pp, ISBN: 978-1-4051-7680-4.

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8.2 Book chapters

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Griffiths, C.L., Robinson, T.B. & Mead, A. (2009). The status and distribution of marine alien species in South Africa. In: *Biological Invasions in Marine Ecosystems*. Rilov, G. and Crooks, J.A. (eds.) Springer-Verlag, Berlin, Heidelberg. Ecological Studies 204, pp. 393-408.

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Hui, C. (2009). A Bayesian solution to the modifiable areal unit problem. In: *Foundations of Computational Intelligence Volume 2: Approximate reasoning*. Hassanien, A.E., Abraham, A. and Herrera, F. (eds.) Springer, Berlin. pp. 175-196.

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8.3 Articles in peer reviewed journals

Abdel-Rahman, E.H., Taylor, P.J., Contrafatto, G., Lamb, J.M., Bloomer, P. & Chimimba, C.T. (2009). Geometric craniometric analysis of sexual dimorphism and ontogenetic variation: A case study based on two geographically disparate species, *Aethomys ineptus* from southern Africa and *Arvicanthis niloticus* from Sudan (Rodentia: Muridae). *Mammalian Biology* **74**, 361-373.

Abril, S., Roura-Pascual, N., Oliveras, J. & Gomez, C. (2009). Assessing the distribution of the Argentine ant using physiological data. *Acta Oecologica* **35**, 739-745.

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Bini, L.M., Diniz-Filho, J.A.F., Rangel, T.F.L.V.B., Akre, T.S.B., Albaladejo, R.G., Albuquerque, F.S., Aparicio, A., Araujo, M.B., Baselga, A., Beck, J., Bellocq, M.I., Böhning-Gaese, K., Borges, P.A.V., Castro-Parga, I., Chey, V.K., Chown, S.L., de Marco, P., Dobkin, D.S., Ferrer-Castán, D., Field, R., Filloy, J., Fleishman, E., Gómez, J.F., Hortal, J., Iverson, J.B., Kerr, J.T., Kissling, W.D., Kitching, I.J., León-Cortés, J.L., Lobo, J.M., Montoya, D., Morales-Castilla, I., Moreno, J.C., Oberdorff, T., Olalla-Tárraga, M.A., Pausas, J.G., Qian, H., Rahbek, C., Rodríguez, M.A., Rueda, M., Ruggiero, A., Sackmann, P., Sanders, N.J., Terribile, L.C., Vetaas, O.R. & Hawkins,

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Bowkett, A.E., Plowman, A.B., Stevens, J.R., Davenport, T.R.B. & Jansen van Vuuren, B. (2009). Genetic testing of dung identification for antelope surveys in the Udzungwa Mountains, Tanzania. *Conservation Genetics* **10**, 251-255.

Braschler, B. (2009). Successfully implementing a citizen-scientist approach to insect monitoring in a resource-poor country. *BioScience* **59**, 103-104.

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8.4 Published conference proceedings

Den Breeeyen, A., Richardson, D.M. & Wingfield, M.J. (2009). *Abstract*: Endophytic fungi in native and exotic Acacia species in South Africa - Friend or foe? *South African Journal of Botany* **75**, 398-399.

Gaertner, M., Den Breeeyen, A., Hui, C. & Richardson, D.M. (2009). *Abstract*: Does invasion by alien plants cause a decline of native species richness? 5 mechanisms across 4 continents - A review. *South African Journal of Botany* **75**, 401-401.

Horn, A. & Esler, K.J. (2009). *Abstract*: Edge effects on plant composition and functional type distribution in renosterveld fragments of the Tygerberg. *South African Journal of Botany* **75**, 405-405.

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Hui, C., Zhang, F., Tao, Y. & Li, Z. (2009). The evolution of cooperation on fragmented landscapes: the spatial Hamilton rule. In: *Proceedings of the International Conference: Evolution of Cooperation – Models and Theories*. International Institute for Applied Systems Analysis, Austria. p. 42.

Iponga, D.M., Milton, S.J. & Richardson, D.M. (2009). *Abstract*: Reproductive potential and seedling establishment of the invasive alien tree *Schinus molle* (Anacardiaceae) in South Africa. *South African Journal of Botany* **75**, 406-406.

Jansen, W., van Rensburg, B.J. & Clusella-Trullas, S. (2009). The importance of morphological traits among dung beetles in the Maputaland Centre of Endemism. In: *Proceedings of the Sixteenth Entomological Congress Organized by the Entomological Society of Southen Africa*. Stellenbosch. (eds. Terblanche, J. and Venter, R.), p. 37. ISBN: 978-0-620-44120-9.

Krug, R.M., Roura-Pascual, N. & Richardson, D.M. (2009). *Abstract*: Prioritising areas for the management of invasive alien plants in the CFR: different strategies, different priorities? *South African Journal of Botany* **75**, 408-409.

Mokotjomela, T.M., Musil, C.F. & Esler, K.J. (2009). *Abstract*: Is *Solanum mauritianum* a preferential food resource for native frugivores in the Cape Floristic Region? *South African Journal of Botany* **75**, 436-436.

Roura-Pascual, N., Krug, R.M. & Richardson, D.M. (2009). *Abstract*: Identifying priority areas for the management of invasive alien plants in the Cape Floristic Region. *South African Journal of Botany* **75**, 439-439.

Slabbert, E., Esler, K.J. & Jacobs, K. (2009). *Abstract*: Microbial community patterns in soils of the Sand fynbos. *South African Journal of Botany* **75**, 440-441.

Thompson, G.D., Le Roux, J.J., Millar, M.A., Wilson, J.R.U., Richardson, D.M. & Byrne, M. (2009). *Abstract*: The Port Jackson 5. *South African Journal of Botany* **75**, 441-442.

Wilson, J.R.U., Procheş, S., Richardson, D.M. & Vamosi, J.C. (2009). *Abstract:* Looking for phylogenetic patterns in species lists. *South African Journal of Botany* **75**, 390-391.

8.5 Products / Artifacts / Patents

None

8.6 Conferences / meetings attended

8.6.1 Plenary/Keynote Presentations

International

Chown, S.L. Macrophysiology as an approach to understand the impacts of environmental change. *European Science Foundation Conservation Genetics and Thermal Adaptation workshop, 'Evolutionary and Physiological Adaptation to Climate Induced Environmental Changes', Mammal Research Institute, Polish Academy of Sciences, Białowieża, Poland, June-July 2009*.

Richardson, D.M. Charles Elton and invasion ecology. *'Invasiones Biológicas en Chile', Facultad de Ciencias Forestales, Universidad de Concepción, Chile, November 2009*.

Richardson, D.M. Invasion ecology in South Africa: The first five years of the DST-NRF Centre of Excellence for Invasion Biology. *11th General Conference and 20th General Meeting of TWAS (Academy of Sciences for the Developing World), Durban, South Africa, October 2009*.

Richardson, D.M. Plant invasions from introduced trees used in forestry. Trends, impacts and potential solutions. *International conference on 'Biosecurity in the New Bioeconomy', Australian Academy of Science, Canberra, Australia, November 2009*.

Samways, M.J. Conserving dragonflies in a rapidly-changing world. *6th International Congress of Odonatology, Xylapa, Mexico, June 2009*.

National

Blignaut, J.N., Aronson J., Limouzin A., Fontaine C., Milton S.J., le Maitre, D., Esler, K. de Wit, M.W., Mugido, W., Prinsloo, P., van der Elst, L., Lederer, N. Quo vadis ecological restoration? A meta-analysis of papers published in Restoration Ecology and in 12

other leading scientific journals, 2000-2008. *35th Congress of the South African Association of Botanists, Stellenbosch, South Africa. 19-22 January 2009*.

Chown, S.L. Animal introductions in southern systems: lessons for ecology and for policy. *50th Anniversary Symposium of the Zoological Society of Southern Africa, Illovo, July 2009*.

Griffiths C.L. Temporal and spatial patterns of marine bio-invasions in South Africa. *Zoological Society of SA Illovo Beach July 2009. Invited keynote address*

Samways, M.J. Provision of ecosystem services by large-scale corridors and ecological networks. Grasslands, Timber and Fire. *Symposium of the Grassland Society of Southern Africa, October 2009*.

Van Wilgen, B.W. Grasslands, timber and alien invasive plants. *Invited keynote speaker at the joint South African National Biodiversity Institute/Grassland Society of Southern Africa symposium on the Ecology and Management of Timber Plantation in Grassland Ecosystems, Pietermaritzburg, October 2009*.

Wilson, J.R., Procheş, Ş, Richardson, D.M. & Vamosi, J. Looking for phylogenetic patterns in species lists. *35th Annual Conference of the South African Association of Botanists, Stellenbosch, South Africa, 19–22 January 2009*

8.6.2 Oral presentations

International

Barnaud, A., Kalwij, J., Born, C., McGeoch, M.A. & Van Vuuren, B. Patterns and pathways of weed invasion: Evidence from the spatial genetic structure of *Raphanus raphanistrum*. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Blanchard, R., O'Farrell, P. & Richardson, D.M. Biofuels – fueling biological invasions? *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Clusella-Trullas, S. Long-term monitoring projects: The Cederberg Coast to Karoo transect and the Soutpansberg transect. *Swiss-South Africa Joint Scientific Conference, Zernez, Davos and Lausanne, Switzerland, November 2009*.

Coetzee, B.W.T., van Rensburg, B.J., Robertson, M.P., Erasmus, B.F.N. & Thuiler, W. Ensemble models predict Important Bird Areas in southern Africa to become less effective for conserving endemic birds under climate change. *23rd Annual meeting of the Society for Conservation Biology, Beijing, China, July 2009*.

De Lange, W. and van Wilgen, B.W. Assessing the costs and benefits of the biological control programme on invasive plants in South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Den Breeÿen, A., Richardson, D.M., Wood A.R., Wingfield, B. & Wingfield, M.J. Role of fungal endophytes in promoting invasiveness of *Acacia* species in South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Engelbrecht, A., Taylor, P., Daniels, S.R., Rambau, RV. Phylogeography of the southern African vlei rat, *Otomys irroratus*, inferred from chromosomal and DNA sequence data. *10th International Mammalogical Congress, Mendoza, Argentina, August 2009*.

Esler, K.J., Sharma, G.P. & Prozesky, H.E. How wide is the 'knowing-doing' gap in invasion biology? *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Foxcroft, L.C., Richardson, D.M., Pyšek, P., Jarošík, V., Rouget, M. & MacFadyen, S. Keeping unwanted neighbours out: protected area boundaries as barriers to alien plant invasions. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Gaertner, M., den Breeyen, A., Hui, C. & Richardson, D.M. Fact or fiction: species richness decline after alien invasions? - a meta-analysis. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Gaertner, M., Richardson, D.M., Privett, S.D.J. Restoration for old fields and areas cleared of alien vegetation – adding ecological and commercial value through fynbos plants. *2nd European Congress of Conservation Biology, (ECCB), Prague, Czech Republic, September 2009*.

Hui, C., Foxcroft, L.C., Richardson, D.M. & MacFadyen, S. Identifying the optimal sampling effort and scheme for estimating the abundance and spatial distribution of invasive alien plants. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Jansen van Vuuren, B., Estes, R., Matthee, C., Robinson, T. & VazPinto, P. Phylogeography of sable antelope: model to understand Southern African biogeography. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

Kongor, R.Y., Horn, A, Krug, C.B & Esler K.J. Combined floristic and functional approaches for the sustainable conservation of the highly transformed, species rich renosterveld shrubland of the fynbos biome. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

Krug, R.M., Roura-Pascual, N. & Richardson, D.M. Towards more efficient management of invasive alien plants in the Cape Floristic Region: optimising the priorities. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Le Roux, J.J., Thompson, G., Wilson, J.R.U. & Richardson, D.M. Is genetic diversity essential to overcome lagphases? Evidence from a few case studies. *Mini Weeds Workshop: Adaptation and Lagphase Dynamics. Adelaide, Australia, September 2009*.

Le Roux, J.J. & Wieczorek, A.M. Genetic diversity of the globally invasive grass *Pennisetum setaceum*. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

McGeoch, M.A. & Spear, D. The CBD 2010 Biodiversity Target: the invasive alien species indicator and national responses. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

McGeoch, M.A. The CBD 2010 targets and beyond: towards a new generation of science based indicators. Plenary Session Round Table (Chair). *Diversitas OSC2, Cape Town, South Africa, October 2009.*

Mokhatla, M.M., Chimimba, C.T. & van Rensburg, B.J. Some aspects of anuran conservation in a South African landscape. *23rd Annual Meeting of the Society for Conservation Biology, Beijing, China, July 2009*.

Perkol-Finkel S, Rius M, Fontana G, Nicotera V, Franzitta G, Ferrario F, Airoldi L. Promoting the growth of desirable assemblages on artificial marine structures: results from experimental tests in the North Adriatic Sea. *9th International Conference on Artificial Reefs and Related Aquatic Habitats. Curitiba, Brazil*

Phiri, E.E., McGeoch, M.A. & Chown, S.L. Co-occurrence: alien and indigenous plants along rivers on Marion Island. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.*

Rahlao, S.J., Milton, S.J., Esler, K.J., Barnard, P. Fountain Grass (*Pennisetum setaceum*) performance along an environmental gradient in South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.*

Rambau, R.V., Broucke, A., & Chimimba C.T. Comparative cytogenetics of southern African rock mice, *Aethomys* (Rodentia: Muridae. *10th International Mammalogical Congress, Mendoza, Argentina, August 2009*.

Richardson, D.M. Are invasive species different?: insights from the study of mutualisms. *Ecological Society of America Annual Conference, Albuquerque, New Mexico, USA, August 2009.*

Richardson, D.M. Managed relocation: A framework for evaluating the use of a new conservation strategy. *Ecological Society of America Annual Conference, Albuquerque, New Mexico, USA, August 2009.*

Richardson, D.M. Trees and shrubs as invasive aliens world-wide: How do pines fit in? *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.*

Rius M, Mead A, Griffiths CL, Carlton JT. Marine introductions in relatively unexplored parts of the world: why do we struggle so much to detect them? *6th International Conference on Marine Bioinvasions Portland USA*

Rius M, Perkol-Finkel S, Turon X, Airoldi L. Establishment and dispersal of invasive ascidians on urban structures. *6th International Conference on Marine Bioinvasions. Portland, USA*

Roura-Pascual, N., Krug, R.M. & Richardson, D.M. Towards more efficient management of invasive alien plants in the Cape Floristic Region: identifying priority areas. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.*

Saldaña, A., Godoy, O., Richardson, D.M. & Castro-Díez, P. Can we predict the invasiveness of the Australian *Acacia* species on the basis of life-history traits and native distribution

ranges? *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Santos, C., Tomé, M., Campagnolo, M. & Richardson, D.M. Modelling of spatial distribution of alien plant species: the case study of *Acacia* in Portugal. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Shaw, J.D. & Chown, S.L. Plant invasion and functional diversity: Southern Ocean Islands as a case study. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Spear, D., Marais, E. & McGeoch, M.A. Challenges to the development of a global indicator for invasive alien plant species. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Spear, D., Marais, E. & McGeoch, M.A. Challenges to the development of a global indicator for invasive alien species. *Programme Diversitas OSC2, Cape Town, South Africa, October 2009*.

Teske P, Rius M, Styan C, Piggott M, McClusky C, Rhamdhani S, Barker N, Banks S, McQuaid CD, Beheregaray L. Cryptic species associated with marine biogeographic provinces within Australian and South African lineages of the low-dispersal ascidian *Pyura stolonifera*. *AMSA Conference 2009: Marine Connectivity. Adelaide, Australia*

Thompson, G.D., Le Roux, J.J., Millar, M.A., Wilson, J.R., Richardson, D.M. & Byrne, M. The Port Jackson 4 - a molecular analysis of *Acacia saligna* across its invasive range. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Urgenson, L., Prozesky, H.E. & Esler, K.J. Multi-stakeholder assessment of alien invasive plant clearing on private land in the Western Cape, South Africa. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

Urgenson, L., Prozesky, H.E. & Esler, K.J. Stakeholder perception and management of alien invasive plants on private land in the Western Cape, South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Uys, C, Picker M & Griffiths CL. Invertebrate faunal exchange in a mosaic of montane native and alien vegetation. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Van Wilgen, B.W and Biggs, H.C. The evolution of adaptive ecosystem management in a large savanna protected area in South Africa. *10th Conference of the International Association of Ecologists (INTECOL), Brisbane, Australia, August 2009*.

Van Wilgen, B.W. & Richardson, D.M. The management of alien conifers in South Africa: three centuries of benefits, impacts and conflict resolution. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Wilson, J.R., Dormontt, E., Prentis, P., Lowe, A., Le Roux, J., Richardson, D.M. Biological invasions vs. natural dispersal and spread. *1st International Congress on Biological Invasions, Fuzhou, China, 2–6 November 2009.*

Wilson, J.R., Zenni, R., Mazibuko, D., van Zyl, H., Le Roux, J.J. & Richardson, D.M. Assessing the feasibility of eradicating Australian *Acacia* species from South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.*

Wise, R., van Wilgen, B.W. and Le Maitre, D.C. Towards the sustainable management of a conflict of interest species: the costs and benefits of prosopis in the Northern Cape. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.*

National

Braschler, B. & Chown, S.L. Changes in beta diversity in ant assemblages along an altitudinal gradient. *ENTSOC 2009, 16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009.*

Coetzee, B.W.T. & Chown, S.L. Effects of change drivers on conservation outcomes. *South African National Biodiversity Institute's Biodiversity Planning Forum, Durban, South Africa, March 2009.*

Davies, S.J. and McGeoch, M.A. 2009. Keeping with up the invasion of the painted reed frog, *Hyperolius marmoratus* in the Western Cape. *C.A.P.E. Invasive Alien Species Seminar, Kirstenbosch Research Centre, Cape Town, 15 April 2009.*

Do Linh San, E., Fattebert, J. & Somers, M.J. Activity patterns of Cape grey mongooses: do sex, photoperiod and weather play a role? *Zoological Society of South Africa 50th Anniversary Conference, Illovo Beach, South Africa, July 2009.*

Edwards, J.M., Davies-Mostert, H.T., Somers, M.J. & Bloomer, P. Conservation genetics of African wild dogs (*Lycaon pictus*) in South Africa. *Zoological Society of South Africa 50th Anniversary Conference, Illovo Beach, South Africa, July 2009.*

Horn, A., Krug, C., Esler, K.J. In ditches and dongas: but down and out? The value of conservation corridors in West Coast Renosterveld. *Fynbos Forum, Bredasdorp. 4-7 August 2009.*

Hugo, S. & van Rensburg, B.J. Bird invasions of South Africa: Spatial distributions and environmental correlates. *Zoological Society of South Africa 50th Anniversary Conference, Illovo Beach, South Africa, July 2009.*

Janion, C., Bengtsson, J., Leinaas, H-P. & Chown, S.L. Landscape conversion and soil biodiversity in the fynbos biome: springtails as exemplars. *ENTSOC 2009, 16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009.*

Jansen van Vuuren, B., Estes, R., Matthee, C., Robinson, T. & VazPinto, P. Sable antelope: what is all the hype about? *Southern African Society for Systematic Biology 10th Anniversary Meeting, Durban, South Africa, July 2009.*

Le Roux, J.J. The Molecular Ecology of Biological Invasions. *37th South African National Biocontrol and Weeds Workshop. Port Alfred, South Africa, May 2009.*

Le Roux, P.C. & McGeoch, M.A. Altitudinal range expansion by the indigenous vascular flora of Marion Island in response to warming. *II South African National Antarctic Programme Principal Investigator and Student Symposium. Cape Town, South Africa, February 2009.*

Lee, J.E. & Chown, S.L. Preventing invasions: practical management solutions. *II South African National Antarctic Programme Principal Investigator and Student Symposium, Cape Town, South Africa. February 2009.*

Mager, D.M., Hui, C., Mills, A.J. & Thomas, A.D. Changes in vegetation structure in southern Africa and the association with soil nutrient content. *Arid Zone Ecology Forum (AZEF), Graaf-Reinet, October, 2009.*

Marnewick, K., Dalerum, F. & Somers, M.J. Modelling habitat selection of cheetahs in South Africa. *South African Wildlife Management Association Annual Symposium, Thaba 'Nchu, South Africa, September 2009.*

Mgobozi, M.P., Somers, M.J. & Dippenaar-Schoeman, A.S. Spider responses to alien plant invasion: the effect of *Chromolaena odorata* management. *Zoological Society of South Africa 50th Anniversary Conference, Illovo Beach, South Africa, July 2009.*

Phiri, E.E., McGeoch, M.A. & Chown, S.L. Co-occurrence: alien and indigenous plants along rivers on Marion Island. *II South African National Antarctic Programme Principal Investigator and Student Symposium. Cape Town, South Africa, February 2009.*

Ruwanza, S., Musil, C.F., Esler, K.J. Does sucrose addition inhibit plant growth by depleting soil N? *Fynbos Forum, Bredasdorp. 4-7 August 2009.*

Shaw, J.D., Spear, D., Greve, M. & Chown, S.L. Invasions of the Southern Ocean Islands: Homogenization or Differentiation? *II South African National Antarctic Programme Principal Investigator and Student Symposium, Cape Town, South Africa. February 2009.*

Terblanche, J.S., Blackburn, T.M., White, C.R., Clusella-Trullas S. & Chown, S.L. Comparative and experimental perspectives on phenotypic plasticity in insect gas exchange characteristics. *ENTSOC 2009, 16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009.*

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Uys, C, Picker M & Griffiths CL. Monitoring invasive alien species for invertebrate conservation in Table Mountian National Park. *Zoological Society of South Africa 50th Anniversary Conference, Illovo Beach, South Africa, July 2009.*

Vorster, C. & McGeoch, M.A. Bait preference of the Argentine ant (*Linepithema humile*) in Jonkershoek Nature Reserve, South Africa. *16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009.*

8.6.3 Poster presentations

International

Barnaud, A., Kalwij, J., McGeoch, M.A. & Van Vuuren, B. Patterns and pathways of weed invasion: evidence from the spatial genetic structure of *Raphanus raphanistrum* in South Africa. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

Cooper, J., Cuthbert R.J., Glass, T., Gremmen N.J.M., Ryan, P.G. & Shaw, J.D. Eradicating procumbent pearlwort *Sagina procumbens* on Gough Island, a World Heritage Site. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Hui, C., Roura-Pascual, N., Robinson, R.A. & Evans, K.L. Effects of dispersal strategy, climate, topography and human facilitation on the range expansion of European starlings in South Africa. *Niche Evolution Conference, Zurich, Switzerland, July 2009*.

Hui, C., Zhang, F., Tao, Y. & Li, Z. The evolution of cooperation on fragmented landscapes: the spatial Hamilton rule. *International Conference: Evolution of Cooperation – Models and Theories, Vienna, Austria, September 2009*.

Mead A, Griffiths CL, Carlton JT, Rius M. Revealing the scale of marine bioinvasions: The South African example. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

Mokotjomela, T.M., Musil, C.F. & Esler, K.J. Is *Solanum mauritianum* a preferential food resource for native frugivores in the Cape Floristic Region? *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Ramaswiela, T., Shaw, J.D. & Chown, S.L. Current status and forecast of alien plant species coverage on sub-Antarctic Marion Island. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Ruwanza, S. & Musil, C., Esler, K.J. Soil nitrogen and phosphorus depletion as a means of restoring degraded lowland fynbos ecosystems invaded by alien grasses. *Diversitas OSC2, Cape Town, South Africa, October 2009*.

Sharma, G. P. & Esler, K.J. Performance of invasive shrub *Lantana camara* L. in two of its invaded ranges: India and South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Somers, M.J., Dalerum, F. & Gusset, M. The effects of fences on population viability of endangered African wild dogs. *INTECOL, Brisbane, Australia, August 2009*.

Suda, J., Le Roux, J.J., Rauchová, J., Thompson, G., Wilson, J.R. & Richardson, D.M. Genome-wide processes in *Acacia*: insights from flow cytometry. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

Wilson, J.R. Dormontt, E., Prentis, P.J., Lowe, A.J. & Richardson, D.M. Something in the way you move: dispersal pathways affect invasion success. *10th International Conference on the*

Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009.

Zenni, R.D., Wilson, J.R.U., Le Roux, J.J. & Richardson, D.M. Evaluating the invasiveness of *Acacia paradoxa* in South Africa. *10th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI10), Spier Estate, Stellenbosch, South Africa, 23-27 August 2009*.

National

Dalerum, F., Somers, M.J., Kunkel, K.E., & Cameron, E.Z. Do we need to reconstruct complete assemblages of large predators in the African savanna? *Kruger Science Networking meeting, Skukuza, South Africa, March 2009*.

Foord, S.H., Muelelwa, M.I., Dippenaar-Schoeman, A.S. Spiders, surrogates and rapid assessment in the Savanna Biome, South Africa. *ENTSOC 2009, 16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009*.

Janion, C., Marais, E. & Chown, S.L. *Species and life stage responses to climate change. II South African National Antarctic Programme Principle Investigator-Student Symposium, University of Cape Town, Cape Town, South Africa, February 2009*.

Jansen, W., van Rensburg, B.J. & Clusella-Trullas S. Morphological traits and bioindicators: a case study on dung beetles in the Maputaland Centre of Endemism. *ENTSOC 2009, 16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009*.

Jansen, W., van Rensburg, B.J. & Clusella-Trullas, S. The importance of morphological traits among dung beetles in the Maputaland Centre of Endemism. *ENTSOC 2009, 16th Congress of the Entomological Society of Southern Africa, Stellenbosch, South Africa, July 2009*. [Best student poster award].

Nowell, M.S., Le Maitre, D.C. and Esler, K.J. Determining the net benefits of clearing invasive alien vegetation on the Agulhas Plain. *Fynbos Forum, Bredasdorp. 4-7 August 2009*.

Purdon, J., Somers, M.J., & Kate Parr. The effect of grazing on habitat complexity: and how habitat complexity, resources and competition interact to structure local ant assemblages. *South African Wildlife management Association Annual Symposium Thaba 'Nchu, South Africa, September 2009*.

Ramaswiela, T., Shaw, J.D. & Chown, S.L. Alien plants distribution across space and time: Marion Island perspective. *II South African National Antarctic Programme Principal Investigator and Student Symposium. Cape Town, South Africa, February 2009*.

Somers, M.J,, Dalerum, F. & Gusset, M. Modelling the effects of fences and fence penetrability on population viability of endangered African wild dogs (*Lycaon pictus*). *7th Annual Savanna Science Network Meeting, Skukuza, South Africa, March 2009*.

Spear, D., Foxcroft, L.C. & McGeoch, M.A. Testing an indicator of alien species status and management in national parks in South Africa. *7th Annual Savanna Science Network Meeting, Skukuza, South Africa, April 2009*.

Swanepoel, L., Delerum, F., Somers, M.J. & van Hoven, W. Density and sustainability of leopard populations in the Waterberg Biosphere. *7th Annual Savanna Science Network Meeting, Skukuza, South Africa, March 2009.*

Treurnicht, M.; Esler, K.J. and Gaertner, M. Impacts of ploughing and introduction of commercial fynbos species on the diversity. *Fynbos Forum, Bredasdorp. 4-7 August 2009.*

8.7 Other relevant outputs

8.7.1 Popular articles and talks

Articles

Anonymous. 2009. Antarctica: the last true wilderness. *Sowetan Youth Magazine*, August 2009, pp. 2.

Anonymous. 2009. Dieretuine benadeel diereverskeidenheid. *Wild en Jag.* Februarie 2009, pp. 11.

Anonymous. 2009. Exploring Antarctica. *Life after school.* July 2009, pp. 28 – 31.

Anonymous. 2009. Invaded – The biological invasion of South Africa. *Environmental Management*. July 2009, pp. 27 – 36.

Anonymous. 2009. Popular science book highlights impact of invasive mussels. *Fishing Industry News Southern Africa.* October 2009, pp. 12.

Burgess, M. 2009. Relocation: the last hope in a warming world. *Farmer's Weekly.* September 2009, pp. 32.

Coetsee, J. 2009. Hoefdiere se diversiteit deur verskuiwings geraak. *Landbouweekblad.* Januarie 2009, pp. 66.

Coetsee, J. 2009. Keer uitwissing van spesies so. *Landbouweekblad.* Augustus 2009, pp. 28.

Cowling, R., van Wilgen, B. and Kraaij, T. 2009. How no-man's land is becoming everyone's problem: Runaway pine invasions in the Outeniqua and Tsitsikamma mountains. *Veld & Flora,* September 2009, pp. 147 – 149.

Davies, S.J. 2009. Tracking the progress of frog invasion in the Cape Peninsula. *ParkNEWS: Table Mountain National Park*. Second Quarter 2009.

Du Plessis, D. 2009. Silent intruders. *Easy Science.* July 2009.

Du Plessis, D. 2009. Silent intruders (cont.). *Easy Science.* August 2009.

Duvenage, E. 2009. Nuwe wetenskapboek takel indringerspesies. *Landbouweekblad.* Augustus 2009, pp. 103.

Foxcroft, L.C. 2009. Are we managing alien plant invasions sensibly? *Veld and Flora.* June 2009, pp. 94 – 95.

Griffiths, C.L 2009. March of the aliens. *Envirokids* 30 (2), pp. 20-21.

Hui, C. 2009. Extrapolating population size. *Bulletin of the Ecological Society of America* **90**, pp. 493-495.

Staff reporter. 2009. Antarctic researcher bags top prize. *Farmer's Weekly.* December 2009, pp. 15.

Van der Merwe, J. 2009. Book review: Gough Island: A Natural History. *Go!,* July 2009.

Wilson, J.R & Zenni, R. D. 2009. Cut me Kangaroo Thorn down, sport! *Veld and Flora*, December 2009, pp. 193.

Talks

Chimimba, C.T. Indigenous and invasive rodents of the highveld. *Oppenheimer & Sons, Johannesburg, November 2008.*

Chown, S.L. A diversity of approaches to biological invasions. *Invited speaker at the Australian Centre for Ecological Risk Analysis, University of Melbourne, Australia, October 2009.*

Chown, S.L. A matrix approach for linking macrophysiology, landscape variation and ecogeographic patterns. *Invited speaker at the Department of Zoology, University of Melbourne, Australia, October 2009.*

Chown, S.L. Biological invasions in the Antarctic: from physiology to policy. *Invited speaker at the Department of Zoology, University of Melbourne, Australia, October 2009.*

Chown, S.L. Macrophysiology – a large-scale approach for understanding and forecasting the impacts of global environmental change. *Invited speaker at the Bioseb Summer School in Ecology and Biodiversity, Mammal Research Institute, Polish Academy of Sciences, Białowieża, Poland, June 2009.*

Chown, S.L. Springtail responses to a changing environment. *Lecture to a delegation of visiting academics and Norwegian Government officials, Stellenbosch, March 2009.*

Chown, S.L. The Antarctic Treaty System. *Presentation to the attendees of the SANAP Antarctic Science Winter School, Hermanus, July 2009.*

Du Plessis, D. Iimbovane Outreach Project - using ants as educational tool. *Invited talk for the Friends of Tygerberg Hills, Tygerberg Nature Reserve, August 2009.*

Esler, K.J. The Ecology of Academia. *Inaugural address. Stellenbosch University, September 2009.*

Esler, K.J. Linking 'knowing' with 'doing': opportunities and constraints. *Opening of the Cape Research Centre, Tokai, Cape Town, October 2009.*

Jansen van Vuuren, B. Conserving the species of the Southern Ocean Islands and stemming the invasion of aliens. *Media conference, Cutting edge research in Antarctica presented by SAASTA and the MTN ScienCentre, Cape Town, July 2009*

Richardson, D.M., Hui, C., Krug, R. & Wilson, J.R. Invasion ecology - Opportunities for collaboration between ecologists and theoretical physicists. *National Institute for Theoretical Physics, Wallenberg Research Centre, Stellenbosch, June, 2009.*

8.8 NRF service provision

8.8.1 Rating and project proposal reviews

Number of reviews completed: 12

[Chimimba (1), Chown (1), Esler, (3), Foord (1), Griffiths (1), Hui (1), Rambau (1), Somers (1), van Wilgen (1), van Vuuren (1)]

8.8.2 Panel and committee service

Advisory Panel: Knowledge Fields Development, SABI (van Vuuren)

SANCOR Steering Committee (Griffiths)

SEAChange Assessment Panel (Griffiths)

SEAChange Programme Management Committee (Griffiths)

8.9 Media interactions

8.9.1 Newspaper Articles

Anonymous. 2009. Antarctica – the last true wilderness. *Sunday World* (Supplement), 22 August 2009.

Anonymous. 2009. Antarctica – the last wilderness. *Daily Dispatch* (Supplement). 12 August 2009.

Anonymous. 2009. Guarding the environment: invaded, the biological invasion of South Africa. *District Mail*, 22 October 2009.

Anonymous. 2009. Insect study claims award. *The Citizen*, 1 June 2009.

Anonymous. 2009. Keeping invaders at bay. *Mail & Guardian*, 29 May 2009.

Anonymous. 2009. Matie scientists win top national awards. *Cape Argus*, 28 May 2009.

Anonymous. 2009. Proffies presteer. *Echo De Aar*, 05 June 2009.

Anonymous. 2009. Skuif van wild bedreig biodiversiteit. *Midlands Nuus*, 3 April 2009.

Anonymous. 2009. The NSTF Award winners for 2008 – 2009. *Business Report*, 4 June 2009.

Anonymous. 2009. US researchers honoured. *Eikestadnuus*, 29 May 2009.

Blaine, S. 2009. Insect research recognised. *Business Day*, 22 May 2009.

Bonthuys, J. 2009. Natuur kan nie as proefkonyn dien. *Die Burger* (Ooskaap), 3 Februarie 2009.

Brits, E. 2009. Stellenbosch-dierekenner kry goue medalje. *Die Burger* (Ooskaap), 29 Julie 2009.

Brits, E. 2009. US-professor wen goue medalje van dierkundiges. *Die Burger*, 29 Julie 2009.

Du Plessis, D. 2009. Ant diversity drive sparks heaps of interest among pupils. *Constantiaberg Bulletin*, 5 November 2009.

Du Plessis, D. 2009. Discover the world of biodiversity looking at ants. *The Plainsman*, 3 October 2009.

Du Plessis, D. 2009. Discover the world of biodiversity through ants. *Table Talk*, 10 June 2009.

Du Plessis, D. 2009. Discovering the world of biodiversity with limbovane. *Athlone News*, 3 June 2009.

Du Plessis, D. 2009. Du Plessis, D. 2009. Have fun exploring the world of ants. *Southern Mail*, 10 June 2009.

Du Plessis, D. 2009. Explore the world of ants. *Atlantic Sun*, 6 June 2009.

Du Plessis, D. 2009. Girls learn about career in science. *Overberg Venster*. 19 June 2009.

Du Plessis, D. 2009. Have fun exploring the world of ants. *Bolander*, 10 June 2009.

Du Plessis, D. 2009. Have fun exploring the world of ants. *Tatler*, 4 June 2009.

Du Plessis, D. 2009. Have fun exploring the world of ants. *Vukani*, 11 June 2009.

Du Plessis, D. 2009. Luhlaza contributes to science. *Vukani*, 29 October 2009.

Du Plessis, D. 2009. Scientists emerge. *Worcester Standard*, 29 October 2009.
Du Plessis, D. 2009. Wetenskaplikes van die toekoms. *Stellenbosch Gazette*, 26 Mei 2009.
Duvenage, E. 2009. Hoefdiere gee groot hoofbrekens. *Buite Burger*, 24 Februarie 2009.
Duvenage, E. 2009. Marioneiland navorser kry doktorsgraad. *Bolander*, 28 Januarie 2009.
Duvenage, E. 2009. Maties professor receives prestigious award. *Bolander*, 24 June 2009.
Duvenage, E. 2009. SA zoologists honour SW biologist. *District Mail*, 20 August 2009.
Duvenage, E. 2009. To move or not to move? *Bolander*, 24 June 2009.
Duvenage, E. 2009. Wild pigs threaten rare tortoise. *Paarl Post*, 17 September 2009.
Jordan, B. 2009. SA's penguins on thin ice. *Sunday Times*, 11 November 2009.
Mckune, C. 2009. Invasion of alien marine species in SA waters. *Cape Argus*, 5 June 2009.
Mckune, C. 2009. Invasive species threaten SA coast. *The Mercury*, 5 June 2009.
Neethling, M. 2009. US-prof vereer vir Antarktiese-navorsing. *Die Burger*, 12 Desember 2009.
Smetherham, J. 2009. Alien plants' threat to Cape farms, biodiversity. *Cape Times*, 22 May 2009.
Tempelhoff, E. 2009. Verskuiwing van wild lei tot verlies van biodiversiteit. *Beeld*, 26 March 2009.
Van Wilgen, B.W. 2009. It's time for the fynbos to come out of the shade: There is a case for clearing pine trees from Table Mountain. *Cape Times*, 21 August 2009.
Van Wilgen, B.W. 2009. Peninsula fynbos is not up to a battle against invasive and pervasive pines. *Cape Argus*, 25 February 2009.
Yeld, J. 2009. Gold medal for zoology professor. *Cape Argus*, 31 July 2009.
Yeld, J. 2009. SA scientist is part of international team doing ground-breaking work. *Cape Argus*, 9 June 2009.

8.9.2 Newsletters

Anonymous. 2009. Long term surveys. SANSA Newsletter No 9. July 2009.
Anonymous. 2009. Professor Steven Chown awarded the first Martha T Muse Prize for Science and Policy in Antarctica. SCAR Newsletter. December 2009.
Anonymous. 2009. Visitors to NCA. SANSA Newsletter No 10. July 2009.
Coetzee, B. Stunning Aldabra. Akkerdier. May 2009.
Den Breeyen, A. 2009. Role of fungal endophytes in promoting invasiveness of Australian Acacia species in South Africa. Plant Protection Research Institute Newsletter No. 79. January-March 2009.
Du Plessis, D. 2009. Iimbovane – making life sciences fun for scholars. Akkerdier. October 2009.
Duvenage, E. 2009. To move or not to move? Scientists debate the pros and cons of managed relocation to save species hit by climate change. SAMWA Newsletter. June 2009.
Duvenage, E. 2009. To move or not to move? Scientists debate the pros and cons of managed relocation to save species hit by climate change. SAMWA Newsletter. June 2009.
Duvenage, E. 2009. Top Stellenbosch researcher receives international Prize for science and policy work in Antarctica. SAMWA Newsletter. December 2009.

Spear, D. 2009. Indicator update: status of alien species invasion. Biodiversity Indicator Partnership Newsletter. March 2009.

Van Zyl, H. 2009. Is *Acacia implexa* a candidate for eradication? Akkerdier. October 2009

8.9.3 Articles published by Stellenbosch University

Du Plessis, D. 2009 Ruimhartige skenking help kinders om biodiversiteit te ontdek. Kampusnuus. Junie 2009.

Duvenage, E. 2009. 2009. Science journalist makes light of invasive species. Campus News, July 2009.

Duvenage, E. 2009. Natuurwetenskappe vier navorsers se prestasies. Kampusnuus. Augustus 2009.

Duvenage, E. 2009. SA Zoologists honour Prof Chown. Matieland. Somer 2009.

Duvenage, E. 2009. SU scientists win three NSTF awards. Kampusnuus. Junie 2009.

Esler, K.J. (2009) The Ecology of Academia. Inaugural address. Stellenbosch University, September. ISBN: 978-0-7972-1280-0

8.9.4 Electronic sources

Anonymous. 2009. Citizen science – research and education. The Pretend Biologist Blog, 23 August 2009. http://pretendbiologist.blogspot.com/2009/08/citizen-science-research-and-education.html

Anonymous. 2009. Congratulations to Prof Chown. The Antarctica Blog, 11 December 2009. http://antarcticablog.blogspot.com/2009/12/congratulations-to-dr-steven-chown.html

Anonymous. 2009. Insect study claims award. The Citizen homepage, 31 May 2009. http://www.citizen.co.za/index/article.aspx?pDesc=96935,1,22

Anonymous. 2009. On the cutting edge of knowledge. Mail & Guardian homepage, 9 September 2009. http://www.mg.co.za/article/2009-09-09-on-the-cutting-edge-of-knowledge

Anonymous. 2009. Professor Chown awarded the first Martha T. Muse Prise for science and policy in Antarctica. Association of Polar Early Career Scientists homepage. 23 December 2009. http://www.apecs.is/apecs-news/1237-professor-steven-chown-awarded-the-first-martha-t-muse-prize-for-science-and-policy-in-antarctica

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Clusella-Trullas, S. 2009. It's only skin deep: melanism and thermoregulation in lizards. Podcast for the Ecological Society of America homepage 'Field talk', 31 August 2009. http://www.esa.org/fieldtalk/?p=154

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Duvenage, E. 2009. Moving animals for lucrative game industry impacts diversity in SA. Science in Africa homepage, July 2009. http://www.scienceinafrica.co.za/2009/june/zoos.htm

Duvenage, E. 2009. Populêre wetenskapboek takel indringerspesies. Universiteit van Stellenbosch tuisblad, 22 Julie 2009. http://blogs.sun.ac.za/news/2009/07/22

Duvenage, E. 2009. Prof Chown internasionaal beloon vir navorsing oor klimaatsverandering, indringerspesies in Antarktika. Universiteit van Stellenbosch tuisblad, 11 Desember 2009. http://blogs.sun.ac.za/nuus/2009/12/11/prof-chown-internasionaal-beloon-vir-navorsing-oor-klimaatsverandering-indringerspesies-in-antarktika/

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8.9.5 Radio and Television

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Chown, S.L. Interviewed for 567 Cape Talk concerning the Martha T. Muse Award for his contribution to science and policy development in Antarctica and the climate change summit in Copenhagen, 10 December 2009.

Du Plessis, D. Interviewed for Ekoforum, the environmental programme of Radio Sonder Grense concerning the Iimbovane Outreach Project, 15 November 2009.

Joubert, L. Interviewed for 567 Cape Talk concerning the SAB Environmental Journalist of the Year Award 2009 for her publication: *Invaded. The Biological Invasion of South Africa*, 30 December 2009.

Le Roux, J. Interviewed for Spektrum, a reality and news programme of Radio Sonder Grense concerning the use of genetics in invasion biology, 22 May 2009.

Mahood, K & Khoza, T. Interviewed for Bush Radar, an environmental programme on SABC 2 concerning the contributions of Iimbovane to biodiversity education. Recorded in August 2008 and aired on 23 October 2009.

Van Wilgen, B.W. 2009. Interview on SABC television and radio regarding the economics of *Prosopis* invasions in the Northern Cape. October 2009.

9 Stage progress

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

Timeframes:

The pending Gate review (Gate 4) shall take place during February or March 2012.
2009: 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.
2009: Board meetings took place on 19 May (following completion of the mid-term review) and 26 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.
2009: Student lists submitted on 30 April (provisional) and 31 July (final)

The CoE will publish 'nuggets' of information on its website and provide these at six-monthly intervals to the NRF.
2009: Nuggets submitted on 12 June 2009 and 29 September 2009

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.
2009: Audited statements were presented to the Board via e-mail on 27 March 2009

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.
2009: 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.
2009: Annual Report completed

The CoE shall submit a Statement of Compliance by no later than March 2012 referring to Stage 4.
2009: n/a

Standard Output Targets per annum in the Current Stage:
Total number of students supported ≥ ***50*** on average per annum
2009: 69 incl. post-docs

Woman students ≥ ***50***% of all students on average per annum
2009: 37 (54%) thus far

Black students ≥ ***50***% of all students on average per annum
2009: 27 (39%) thus far

Number of social science students ≥ ***2*** on average per annum
2009: 2 (3%) thus far

Average duration of submitted Masters degrees (post Honours) ≤ ***2.5*** years at end of stage
2009: 2.7 years, thus far

Average duration of submitted Ph.D. degrees (post Masters) ≤ ***3.5*** years at end of stage
2009: 3.5 years, thus far

Average duration of submitted Ph.D. degrees (upgraded from Masters) ≤ ***5*** years at end of stage
2009: None for 2009

Post-doctoral researcher ≥ ***10***% of all students at end of stage
2009: 26% (18)

Each core team member must undertake at least one scientific review per annum on behalf of the NRF (postal peer review process or panel)
2009: 12

Number of patents ≥ ***0***
2009: n/a

Number of peer reviewed publications ≥ ***60*** on average per annum
2009: 92

Number of peer reviewed publications ≥ ***1*** with an impact rating of ≥ ***15*** on average per annum
2009: 1

Number of peer reviewed publications ≥ ***10*** with an impact rating of ≥ ***3.5*** on average per annum
2009: 26

Number of national conference presentations ≥ ***20*** on average per annum
2009: 40 (6 invited, plenary and keynote; 22 oral; 12 poster)

Number of international conference presentations ≥ ***10*** on average per annum
2009: 63 (5 invited, plenary and keynote; 45 oral; 13 poster)

Number of joint venture student training initiatives ≥ ***20*** on average per annum
2009: 30 (15 Academy students; 15 co-supervisions)

Number of local conferences organized ≥ ***1*** at end of stage
2009: 0

Number of international conferences organized ≥ ***1*** at end of stage
2009: 1

Special Output Targets for the Current Stage:
At least one full CoE team activity per annum.
2009: Annual Research Meeting held on 27-28 November; one CTM did not attend

Successful expansion of Iimbovane outreach project to additional schools in the WCED region.
2009: The project was successfully implemented in five new full participation schools and ten new subscription schools.

10 Conclusion

The C·I·B continues to show exceptional performance across all of its areas of activity, and is now widely recognized internationally as one of the key research entities in the field.

11 Finances

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2009

CONTENTS **Page**

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

.....

25/03 2010

DATE

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF FINANCIAL POSITION AS AT 31 DECEMBER 2009

	Notes	2009 R	2008 R
ASSETS			
NON-CURRENT ASSETS		1 152 263.76	1 234 059.26
Equipment and vehicles	3	1 152 263.76	1 234 059.26
CURRENT ASSETS		2 164 398.68	1 588 628.51
Trade and other receivables	4	652 488.95	7 340.00
Stellenbosch University	5	1 511 909.73	1 581 288.51
TOTAL ASSETS		**3 316 662.44**	**2 822 687.77**
EQUITY AND LIABILITIES			
CAPITAL AND RESERVES		3 000 500.05	2 600 668.45
Accumulated funds		3 000 500.05	2 600 668.45
CURRENT LIABILITIES		316 162.39	222 019.32
Trade and other payables	6	316 162.39	222 019.32
TOTAL FUNDS AND LIABILITIES		**3 316 662.44**	**2 822 687.77**

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDING 31 DECEMBER 2009

	2009 R	2008 R
Revenue	6 803 557.00	6 546 052.00
Other income	5 059 858.80	3 021 079.56
Operating expenses	(11 666 254.63)	(9 419 151.45)
Operating profit	197 161.17	147 980.11
Finance income	203 581.11	287 464.03
Finance cost	(1 210.68)	(193.10)
Surplus for the year	399 531.60	435 251.04
Other comprehensive income	-	-
Total comprehensive income for the year	399 531.60	435 251.04

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 DECEMBER 2009

	2009 R	2008 R
ACCUMULATED FUNDS		
At the beginning of the year	2 600 968.45	2 165 417.41
Total comprehensive income for the year	399 531.60	435 551.04
At the end of the year	**3 000 500.05**	**2 600 968.45**

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 31 DECEMBER 2009

	2009 R	2008 R
CASH FLOW FROM OPERATING ACTIVITIES		
Net surplus for the year	399 531.60	435 251.04
Adjustment for:		
Interest received	(203 581.11)	(287 464.03)
Interest paid	1 210.68	193.10
Exchange rate loss/(gain)	6 963.36	(333.32)
Depreciation	414 876.38	400 619.70
Loss/(profit) on sale of equipment and vehicles	2 468.78	(96 859.32)
Operating profit before working capital adjustments	621 469.69	451 407.17
Working capital adjustments	(557 969.24)	196 828.13
(Increase)/decrease in trade and other receivables	(645 148.95)	145 708.00
Increase in trade and other payables	87 179.71	51 120.13
Cash generated from operations	63 500.45	648 235.30
Interest received	203 581.11	287 464.03
Interest paid	(1 210.68)	(193.10)
NET CASH FLOW FROM OPERATING ACTIVITIES	265 870.88	935 506.23
CASH FLOW FROM INVESTMENT ACTIVITIES		
Equipment and vehicles purchased	(335 249.66)	(469 904.14)
Proceeds from disposal of equipment and vehicles	-	112 323.84
Decrease/(increase) in amount owed by Stellenbosch University	69 678.78	(577 925.93)
NET CASH FLOW FROM INVESTMENT ACTIVITIES	(265 570.88)	(935 506.23)
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 2009

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

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 balance sheet 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.

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2009 (continued)

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, refunds received for expenditure incurred 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 group's accounting periods beginning on or after 1 January 2010 or later periods, but the group has not early adopted them:

- AC 140 - Business Combinations (effective from 1 July 2009) (2)
- AC 132 - Consolidated and Separate Financial Statements (effective from 1 July 2009) (2)
- AC 133 - Amendments to IAS 39 Financial Intruments: Recognition and Measurement Exposures Qualifying for Hedge Accounti (effective from 1 July 2009) (2)
- AC 138 - First-Time Adoption of International Financial Reporting Standards - Revised (2) (effective from 1 July 2009) (2)
- AC 139 - Amendments to IRFS 2: Group cash-settled sharebased payment transactions (effective from 1 January 2010) (2)
- AC 125 - Amendment to IAS 32 - Classification of rights issues (effective from 1 February 2010) (2)
- AC 504 - IAS 19 (AC 116) - The Limit on a Defined Benefit Asset, Minimum Funding Requirements and their Interaction in the South African Pension Fund Environment (effective from 1 April 2009) (2)

(1) The financial statements will be affected mainly by additional disclosures.
(2) No material effects on the consolidated financial statements.

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2009 (cc

1. ACCOUNTING POLICY (continued)

IMPROVEMENTS PROJECT

This is a collection of amendments to IFRS. These amendments are the result of considerations the International Accounting Standards Board (IASB) reached on proposals made in its annual improvements project. The annual improvements project provides a vehicle for making non-urgent but necessary amendments to IFRSs. Some amendments involve consequential amendments to other IFRSs. The amendments are effective from 1 January 2010.

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

AC 139, Share-based Payment
- Scope of IFRS 2 and revised IFRS 3

AC 142, Non-current Assets Held for Sale and Discontinued Operations
- Disclosures of non-current assets (or disposal groups) classified as held for sale or discontinued operat

AC 145, Operating Segments
- Disclosure of information about segment assets

AC 101, Presentation of Financial Statements
- Current/non-current classification of convertible instruments

AC 118, Statement of Cash Flows
- Classification of expenditures on unrecognised assets

AC 105, Leases
- Determining whether an entity is acting as a principal or as an agent

AC 128, Impairment of Assets
- Unit of accounting for goodwill impairment test

AC 129, Intangible Assets
- Additional consequential amendments arising from revised IFRS 3
- Measuring the fair value of an intangible asset acquired in a business combination

AC 133, Financial Instruments: Recognition and Measurement
- Treating loan prepayment penalties as closely related embedded derivatives
- Scope exemption for business combination contracts
- Cash flow hedge accounting

AC 442, Reassessment of Embedded Derivatives
- Scope of IFRIC 9 and revised IFRS 3

AC 449, Hedges of a Net Investment in a Foreign Operation
- Amendment to the restriction on the entity that can hold hedging instruments

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.

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2009 (continued)

3. EQUIPMENT AND VEHICLES

	Equipment R	Vehicles R	TOTAL R
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)
31 December 2008			
Carrying amount at the beginning of the year	957 965.36	222 273.98	1 180 239.34
Cost	1 584 567.92	347 143.82	1 931 711.74
Accumulated depreciation	(626 602.56)	(124 869.84)	(751 472.40)
Additions during the year	191 583.04	276 222.10	467 805.14
Transfers	2 099.00	-	2 099.00
Disposals	(2 107.80)	(13 356.72)	(15 464.52)
Cost	(3 978.00)	(251 543.82)	(255 521.82)
Accumulated depreciation	1 870.20	238 187.10	240 057.30
Depreciation for the year	(341 226.17)	(59 393.53)	(400 619.70)
Carrying amount at the end 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)

	2009 R	2008 R
4. TRADE AND OTHER RECEIVABLES		
Trade receivables	626 208.64	6 000.00
Other	26 280.31	1 340.00
	652 488.95	7 340.00
The ageing of these receivables are as follows:		
Up to 2 months	626 208.64	6 000.00
2 to 6 months	-	-
	626 208.64	6 000.00

5. STELLENBOSCH UNIVERSITY

The loan to Stellenbosch University is not secured and is subject to interest rates linked to prime. The loan has no fixed terms of repayment.

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2009 (continued)

	2009 R	2008 R
6. TRADE AND OTHER PAYABLES		
Leave pay provision	267 329.15	190 499.32
Other creditors	10 210.04	720.00
Provision for audit fees	38 623.20	30 800.00
	316 162.39	222 019.32

7. INCOME TAX

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

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.

Foreign exchange risk

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.

Fair values

At 31 December 2009 and 2008 the carrying amounts of receivables and payables approximated their fair values due to the short-term maturities of these assets and liabilities.

	Carrying value R	Contractual cash flows R	< 1 year R	1 - 5 years R	> 5 years R
Financial liabilities					
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	-	-
31 December 2008					
Trade and other payables	222 019.32	222 019.32	222 019.32	-	-
Net financial liabilities	222 019.32	222 019.32	222 019.32	-	-

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 2009

	2009 R	2008 R
INCOME	12 066 996.91	9 854 595.59
Exchange rate gain	-	333.32
Interest received	203 581.11	287 464.03
National Research Foundation grant	6 803 557.00	6 546 052.00
Other income	5 059 858.80	2 923 886.92
Profit on sale of equipment and vehicles	-	96 859.32
EXPENDITURE	11 667 465.31	9 419 044.55
Operational expenses	7 537 779.03	6 275 368.61
Advertisements	212 641.66	62 252.84
Audit fees - current year	38 623.20	30 800.00
- previous year underprovision	4 312.00	1 120.00
Consumables	50 610.19	33 982.23
Consultation	-	5 931.80
Copying and stationery	89 452.99	48 728.48
Depreciation	414 876.38	400 619.70
Entertainment	39 152.23	11 567.30
Exchange rate loss	6 963.36	1 058.39
Interest paid	1 210.68	193.10
Insurance	3 600.00	23 396.92
Levies	222 106.97	159 312.05
Loss on sale of of equipment and vehicles	2 468.78	-
Membership and affiliation fees	29 777.14	181 728.33
Non-capitalised books	3 156.70	1 014.75
Small capital works: not capitalised	94 132.50	63 355.56
Postage, telephone and fax	83 986.75	66 400.59
Publishing costs	-	14 035.04
Safety clothing	325.00	4 418.89
Research costs	-	232 033.34
Rent paid for facilities	412.19	17 989.20
Repairs	13 177.30	42 631.75
Software and internet	19 031.28	26 732.40
Sundry expenses	34 652.14	22 637.25
Team member research costs	5 735 663.13	4 281 331.18
Transport and accommodation	426 046.46	496 356.19
Workshops	11 400.00	45 441.33
Personnel expenses	4 129 686.28	3 143 975.94
Salaries	4 129 686.28	3 143 975.94
SURPLUS FOR THE YEAR	399 531.60	435 551.04