DST-NRF Centre of Excellence for Invasion Biology

UNIVERSITEIT STELLENBOSCH UNIVERSITY

Cardiospermum halicacabum

DST-NRF Centre of Excellence for Invasion Biology

ANNUAL PROGRESS REPORT

2011

Lantana camara

Pseudobarbus afer

National Research Foundation

Working for Water — Patron in Chief Nelson Mandela

South African national biodiversity institute SANBI

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ANNUAL PROGRESS REPORT

Reporting period from 1 January 2011 to 31 December 2011

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: 1 March 2012
	:	Financials: 15 March 2012

Summary of progress against 5 KPAs

(i) Research

Centre members contributed 120 peer-reviewed articles to the research literature, including in the journals *Science*, *PNAS*, and *Ecology Letters*, wrote 22 book chapters, and co-authored or edited three books. Much progress was made in each of the major strategic research areas, but with special emphasis on biodiversity dynamics; global environmental change, biological invasions, ecosystem services and sustainability; and detection, deterioration, restoration, reintroduction. Growth in the latter field reflects the significance of the Centre's partnershsips with Natural Resources Management Programmes (previously Working for Water) and the South African National Biodiversity Institute, whilst the growing contribution to environmental change work reflects investment from Stellenbosch University's HOPE project. All of these areas continue to imvolve substantial training via higher degree research.

(ii) Education and Training

Seventy four were supported at post-graduate level. Eighteen of these students completed their studies in 2011, and specifically five B.Sc. (Honours), nine M.Sc. and four Ph.D. students. The high quality of student work was recognized through outside awards to several students. Over the current period, 47% of the students supported by the Centre are black and 63% are women. The Biodiversity Academy, held in conjunction with the University of Cape Town, supported fourteen students and interns from seven universities and two public entities.

(iii) Information Brokerage

In addition to the 120 research papers, 22 book chapters and three books, the C·I·B made several other significant contributions to information brokerage. These included many communications via talks or posters at scientific conferences (seven plenary/key note talks and a further 81 oral or poster presentations), a wide variety of invited public lectures, including the NRF's first Science for Society Lecture, and many media interactions. The C·I·B hosted the 7th Scientific Committee on Antarctic Research History Workshop at Stellenbosch University in July 2011. Along the theme of 'Antarctic History: Probing the

Unknown', workshop attendees from ten countries reflected on current historical and archaeological research being done on Antarctica.

The Iimbovane Outreach project continued to gain ground, now encompassing 28 schools and 1151 learners in 2011. In addition to the usual lesson plans and activities for learners and educators, the Iimbovane project also made three outreach visits to partner schools, held two learner workshops, participated in national expos and facilitated several educator workshops. At Scifest Africa, held in Grahamstown, Iimbovane staff presented the 'Antastic' workshop which was awarded the prize for the best Scifest outreach workshop. Much of Iimbovane's work is funded by corporate social investment from Rand Merchant Bank, AfriSam, and from Anglo American. The project was recognized in an international article as being one of the most successful initiatives globally for sensitizing young adults to the significance of biodiversity.

The C·I·B's Information Retrieval and Submission System (IRSS) now contains a total of 924 items. These include 63 long-term projects datasets; 695 core team member publications; 83 datasets and theses, and 83 post-doc and student outputs.

(iv) Networking
Centre members contined to engage in a wide variety of interactions with colleagues at the research collaboration level. These have resulted in many co-supervisions of students, joint grant proposals and multi-author research papers with colleagues from around the world and at South African insititutions. Although no new formal agreements with research institutions were established, an agreement with the Drakenstein Trust has enabled the Centre to fund students in key areas of plant invasion biology.

(v) Service rendering
Scientific service to the broader community continues to grow within the Centre. Researchers contributed to more than 20 national and 15 international panels or committees boards, edit or contribute to the editing of three journals, and serve in an editorial role on the boards of more than 30 journals. Centre members also served on several NRF panels, including for the SARChI Chairs round in 2011, and undertook 27 reviews for the NRF.

What was the gender impact of your work?
The Centre staff and student complements reflect an on-going promotion of the interests of women in science, whilst research into the impacts of the Working for Water programme include an emphasis on the role of women.

Red Flags. Please indicate any major concerns you have for the future of your CoE
Some funding uncertainty remains from all major funders of the Centre. Without clarification of support, student intake will have to decline markedly from 2013 onwards, unless an alternative model for support is found or the funding situation changes.

General Comments
The C·I·B can rightly be considered an excellent investment by all its partners, delivering globally competitive research, excellent human resources, award-winning community engagement and significant service in an integrated manner.

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, especially climate change, might further influence the impacts of biological invasions and alter policy advice. In consequence, investigations across a wide range of disciplines, taxa, and spatial and temporal scales will continue to be supported, with long-term research constituting a central element thereof.

A variety of scientific approaches continues to be encouraged. These range from the 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 evolves. In addition to exploring the fields which are set out as targets below, the C·I·B will continue to consider new areas of work to ensure that it stays at the leading edge of research in the sector.

Much of the work undertaken over the past year is still in progress, and in keeping with our reporting policy, will be set out in detail once published. This report therefore largely concerns published work, except for progress on some aspects of the Centre's long-term work.

1.2 Progress

Research output in the primary literature for 2011 encompasses 120 peer-reviewed publications, with significant contributions such as to the journals *Science*, *PNAS*, and *Ecology Letters*. Three authored and edited books, both scientific and popular, appeared (three in total), along with 22 book chapters. The overview below provides highlights of the C·I·B's research outcomes over the past year following the Strategic Plan framework. A complete list of published work can be found elsewhere in this report, and the C·I·B homepage provides overviews of noteworthy and newsworthy research publications (see www.sun.ac.za/cib and follow the links).

1.2.1 Long-term Research

A. Long term change in insect assemblages

The primary long-term projects encompass repeated, twice-annual sampling across altitudinal gradients in the Cederberg (9 years), Drakensberg (5 years) and Soutpansberg (6 years), while the fourth one draws on data collected by the Iimbovane outreach project across the Western Cape. The projects are supported by the C·I·B central funds, by each of the primary institutions involved (Stellenbosch, Pretoria and Venda Universities) and, in the case of the Iimbovane project, by corporate social investment (currently Rand Merchant Bank, AfriSam and Anglo American).

These projects are all largely on track, with identifications being up to date for all of them, or at most with a six month lag, which is to be expected given the scale of the work. Comprehensive additional data sets on insect body size and thermal tolerances, and on

vegetation structure have also been developed, and analyses thereof are underway. These are crucial for developing a mechanistic understanding of assemblage variation.

One key area of work that is associated with long-term data collection priorities has been research directed at understanding the form of the intra-specific body size distribution (IaBSFD) in a variety of insects. Variation in these distributions is not well understood at the intraspecific level for most taxa, although for ants some progress has been made. Often the assumption is made that for most insects the distributions are Gaussian, whereas in ants they may be multi-modal. One part of our work has therefore been to review current understanding and expand knowledge in this area. In doing so, data on IaBSFDs for 16 species of insects based on both mass and linear estimates and large sample sizes (n >100) were collected and the published IaBSFDs for insects were reviewed (Gouws *et al*. 2011 *PLoS One*). The latter is complicated by their under-emphasis in the literature. The form of IaBSFDs can differ substantially between mass-based and linear measures. Nonetheless, in non-social insects they tend to be normally distributed (18 of 27 species) or in fewer instances positively skewed. Negatively skewed distributions are infrequently reported and log transformation readily removes the positive skew. Sexual size dimorphism does not generally cause bimodality in IaBSFDs. The available information on IaBSFDs in the social insects suggests that these distributions are usually positively skewed or bimodal (24 of 30 species). However, only c. 15% of ant genera are polymorphic, suggesting that normal distributions are probably more common, but less frequently investigated. Although only 57 species, representing seven of the 29 Orders of insects, have been considered here, it appears that whilst IaBSFDs are usually normal, other distribution shapes can be found in several species, though most notably among the social insects. By contrast, the interspecific body size frequency distribution is typically right-skewed in insects and in most other taxa.

The second development with our long-term work is our contributions to the Barcoding of Life Database. The Centre has so far contributed 950 specimens of springtails and ants, and 694 specimens of plants. Part of the work has been done with support of the South African Institute of Aquatic Biodiversity and part with the assistance of a set of interns supported by the South African National Biodiversity Institute. The Centre's work in this area is not restricted solely to barcoding approaches, but is also being augmented by more traditional taxonomic approaches. So far several new springtail taxa have been described from the work and a comprehensive listing of the fauna is now being compiled (see Janion *et al*. 2011 *S.A. J. Sci,* Janion *et al*. 2011 *ZooKeys*; Potapov *et al*. 2011 *Zootaxa*).

B. Long term changes to the Prince Edward Island ecosystem

Long-term work on the islands has continued with special emphasis on assessing climate-related influences on insect size (see also above), and changes in the distribution of arthropods and plants. One of the matters that was clarified for the long-term work was the systematic status of several weevil species on the islands. Initial genetic data suggested that cryptic species might be found on the island. Such cryptic species would influence the assessment of size change and assessment of the influence of past climate change on the distributions of species across the region. Indeed, the biogeography of the South Indian Ocean Province (SIP) biotas has long been controversial for this reason. Much of the discussion has been based on interpretation of species distributions, based on morphological or anatomical delimitations. However, molecular phylogenetic approaches elsewhere have recently shown that interpretations based solely on morphological data may be misleading. Nonetheless, few studies have employed molecular phylogenetic

approaches to understand the biogeography of the SIP biotas. Centre researchers and their colleagues did so for the *Ectemnorhinus* group of genera, a monophyletic unit of weevils endemic to the region (Grobler *et al*. 2011a, b *Antarct. Sci*.). They used mitochondrial cytochrome oxidase I DNA sequence data to reconstruct relationships among 13 species and 22 populations in the genera *Palirhoeus*, *Bothrometopus* and *Ectemnorhinus*. On the basis of this analysis they found little support for separating the genus *Palirhoeus* from *Bothrometopus*, and little support for the morphologically-based species groups currently recognized within *Bothrometopus*. Using a molecular clock they showed that dispersal among islands probably took place against the prevailing wind direction. These data also support a previous hypothesis of radiation of the epilithic genera *Bothrometopus* and *Palirhoeus* during the Pliocene/early Pleistocene, but reject the hypothesis that the genus *Ectemnorhinus* radiated following the last glacial maximum. The researchers also showed that *Bothrometopus parvulus* (C.O. Waterhouse) on the Prince Edward Islands comprises two species that are not sister taxa. The second species was named *Bothrometopus huntleyi* in honour of Prof. Brian J. Huntley, one of the original (1965-1966) scientific team members on the Prince Edward Islands.

Following on from this finding the researchers also assessed the relationships among populations of this new species on the two islands of the Prince Edward group. *Bothrometopus huntleyi* is a flightless weevil endemic to the volcanic Prince Edward Islands archipelago, that arose approximately 0.5 million years ago (m.y.a.). Since emergence, a series of volcanic and glaciation events have occurred on Marion Island, whilst Prince Edward Island, the second island constituting the archipelago, has remained largely unaffected by glaciation. Cytochrome oxidase I gene analyses indicate that major historical dispersal events in this species are linked to the geologically discrete histories of these islands and underlie the high haplotype diversity (0.995) recovered for the Prince Edward Islands archipelago. The estimated time to haplotype coalescence of c. 0.723 m.y.a. is in keeping with estimated dates of island emergence, and the majority of individuals appear to have descended from a relict, high-altitude population that is still present on Marion Island. The first major inter-island dispersal event occurred c. 0.507 m.y.a., coinciding with the oldest dated rocks on Marion Island. Apart from this early inter-island colonization, only one other between-island dispersal event was detected. The genetically discrete *B. huntleyi* complexes on each of the islands of the Prince Edward Islands archipelago together with the low levels of inter-island gene flow reaffirm the need to control alien invasive mice, which are restricted to Marion Island, and which prey on this weevil species.

Based on the above findings data on body size change in the weevils through time have been re-interpreted and the findings of a 30-year assessment of predation and climate-related size change have been incorporated into a student's Ph.D. thesis, and will be published in 2012.

1.2.2 Short-term Research

A. Biodiversity foundations

The architecture of ecological networks is one of the most important research priorities in ecology. Earlier work reported the distinctive feature of nestedness in many plant-animal mutualistic networks, such as in pollination and seed dispersal communities. However, an integrative and quantitative explanation for the importance of networks has been lacking. Because mutualistic interactions are crucial for sustaining ecosystem functioning and services, generating biodiversity, and affecting community stability, it is important to

reveal the potential mechanisms behind this particular structure in many ecological networks. Researchers from the C·I·B recently presented the first mathematical model to explain the emergence of nestedness in ecological networks (Zhang *et al.* 2011 *Ecol. Lett.*). Besides fitting remarkably well with observations from 81 empirical networks, their model also explained four well known patterns in mutualistic networks and even structures in antagonistic networks, such as predator-prey networks and food webs. Importantly, they demonstrated that a mutualistic network converges from an initial random network to a nested network with an intrinsic stable level of nestedness, suggesting that the observed nested architecture could depend solely on the physical features of the network. Biological and ecological patterns in this regard only reflect the physical features of adaptive networks.

Great strides have been made in understanding the systematics of springtails, in the Western Cape especially. Despite their significance in soil ecosystems and their use for investigations of soil ecosystem functioning and for bioindication elsewhere, springtails (Collembola) have not been well investigated in South Africa. Early recognition of their role in soil systems and sporadic systematic work has essentially characterised knowledge of the southern African fauna for some time. The situation is now changing as a consequence of our systematic and ecological work on springtails. To date this research has focused mostly on the Cape Floristic Region and has revealed a much more diverse springtail fauna than previously known (136 identifiable species and an estimated 300 species for the Cape Floristic Region in total), including radiations in genera such as the isotomid *Cryptopygus* (Janion *et al*. 2011 *S.A. J. Sci*). Several new species for the region have been described in collaboration with partners from France (Janion *et al*. 2011 *ZooKeys*; Potapov *et al*. 2011 *Zootaxa*). Quantitative ecological work has shown that alpha diversity can be estimated readily and that the group may be useful for demonstrating land use impacts on soil biodiversity. Moreover, this ecological work has revealed that some disturbed sites, such as those dominated by *Galenia africana*, may be dominated by invasive springtail species. On-going research on the springtails will provide the information necessary for understanding and conserving soils: one of southern Africa's major natural assets.

In a totally different area Centre researchers have started to change the way physiological ecologists think about the assessment of traits most significant to ectotherms (Terblanche *et al*. 2011 *J. Exp. Biol*.). Following on from earlier work we have now set out a clear framework for thermal tolerance investigations. The acute thermal tolerance of ectotherms has been measured in a variety of ways; these include assays where organisms are shifted abruptly to stressful temperatures and assays where organisms experience temperatures that are ramped more slowly to stressful levels. Ramping assays are thought to be more relevant to natural conditions where sudden abrupt shifts are unlikely to occur often, but it has been argued that thermal limits established under ramping conditions are underestimates of true thermal limits because stresses due to starvation and/or desiccation can arise under ramping. These confounding effects might also impact the variance and heritability of thermal tolerance. We argued here that ramping assays are useful in capturing aspects of ecological relevance even though there is potential for confounding effects of other stresses that can also influence thermal limits in nature. Moreover, we showed that the levels of desiccation and starvation experienced by ectotherms in ramping assays will often be minor unless the assays involve small animals and last for many hours. Empirical data illustrate that the combined effects of food and humidity on thermal limits under ramping and sudden shifts to stressful conditions are unpredictable; in *Drosophila*

melanogaster the presence of food decreases rather than increases thermal limits, whereas in *Ceratitis capitata* it has little impact. The literature provides examples where thermal limits are increased under ramping presumably because of the potential for physiological changes leading to acclimation. It is unclear whether heritabilities and population differentiation will necessarily be lower under ramping because of confounding effects. Although it is important to define clearly experimental methods, particularly when undertaking comparative assessments, and to understand potential confounding effects, thermotolerance assays based on ramping remain an important tool for understanding and predicting species responses to environmental change. An important area for further development is to identify the impact of rates of temperature change under field and laboratory conditions.

In the context of global environmental change much of the focus has been on changing temperatures. However, patterns of rainfall and water availability have also been changing and are expected to continue doing so. In consequence, understanding the responses of insects to water availability is important, especially because it has a pronounced influence on insect activity, distribution patterns, and species richness. In a recent paper (Chown *et al*. 2011 *J. Insect Physiol*.) Centre researchers provided a critical review of key questions that either are being or need to be addressed in this field. First, an overview of insect behavioural responses to changing humidity conditions and the mechanisms underlying sensing of humidity variation was provided. The primary sensors in insects belong to the temperature receptor protein superfamily of cation channels. Temperature-activated transient receptor potential ion channels, or thermoTRPs, respond to a diverse range of stimuli and may be a primary integrator of sensory information, such as environmental temperature and moisture. Next the components of water loss were considered, drawing attention to a new, universal model of the water costs of gas exchange and its implications for responses to a warming, and in places drying, world. An overview of new understanding of the role of the sub-elytral chamber for water conservation, and developments in understanding of the role of cuticular hydrocarbons in preventing water loss was also developed. Because of an increasing focus on the molecular basis of responses to dehydration stress this area was reviewed briefly, drawing attention to the cellular-level roles of sugars, heat shock proteins, aquaporins, and LEA proteins. The work also considered phenotypic plasticity or acclimation responses in insect water balance after initial exposures to altered humidity, temperature or nutrition. Although beneficial acclimation has been demonstrated in several instances, this is not always the case. Laboratory studies show that responses to selection for enhanced ability to survive water stress do evolve and that genetic variation for traits underlying such responses does exist in many species. However, in others, especially tropical, typically narrowly distributed species, this appears not to be the case. Using the above information we then demonstrated that habitat alteration, climate change, biological invasions, pollution and overexploitation are likely to be having considerable effects on insect populations mediated through physiological responses (or the lack thereof) to water stress, and that these effects may often be non-intuitive.

B. Biodiversity dynamics through space and time

Much theoretical and empirical work was completed in this area of interest over the past year. One of the significant areas addressed was whether boundaries act as barriers to invasions. A dataset of invasive alien plants for the Kruger National Park (KNP) provides a unique opportunity to test this idea. The KNP covers 20,000 km² (equivalent to the area of Wales), extends about 360 km north to south, and has a boundary perimeter of about 1020

km. More than 27,000 spatially-explicit alien plant records are available. Using a PDA (personal digital assistant) with integrated GPS, and loaded with customised CyberTracker software, rangers in the KNP have collected data on features they observe in the field during their daily patrols. They not only record alien plants but many other observations such as rare animals, surface water availability, carcasses, fence breaks and many others. A major strength of the dataset is that these other (non-alien plant) observations can be used as absence records, since alien plants would be recorded at these sites if they were present. The total dataset (with these 'absence' records) amounted to about 2 million records. The records formed the basis of the study conducted by the C·I·B (Foxcroft *et al*. 2011; *Cons. Biol*.). Plotting and analysing the distance of the plant records from the boundary revealed a very clear pattern. At almost exactly 1500 m from the boundary the numbers of alien plants dropped off sharply (Figure 1). To test whether this may be an artefact of the data and collection methods, another analysis was undertaken, this time using the ratio of alien plants to absence records in bands radiating into the park. The same pattern emerged again showing that the pattern is a robust result.

Using this knowledge, the next step was to determine whether the factors responsible for this effect could be identified. Outside the park, starting at the boundary and extending away from the park, the Centre researchers determined the density of major (national) roads, all roads (including secondary and gravel), land use outside the park boundary, mean annual water runoff, presence of protected or natural areas, primary productivity of vegetation, and other variables; in total they had 37 variables to test. Average annual water runoff from the catchment outside the park was the most important variable for explaining the presence of alien plant records. It appears that there is a quantifiable threshold value of water runoff from surrounding areas below which invasion of alien plants is less likely. However, in these areas of lower runoff the chances of having alien plants present was only likely in areas with high road density within 10 km outside the park boundary. Furthermore, where rivers flowed into the park alien plants were only absent in areas where natural vegetation (although also possibly also grazed by livestock) comprised over 90% of the land use in a 5 km radius outside the boundary, and where there were no roads along the boundary inside the park. This suggests that areas of high road density adjacent to the park boundary should be prioritised for control and surveillance due to their higher potential for invasion.

What do these results mean for the Kruger National Park and other protected areas? First, the fact that the boundary acts as a natural filter means that maintaining a corridor along the boundary free of alien plants has the potential to reduce significantly the incursion of alien plants into the park across the landscape. Park managers cannot control alien plants in the broader catchments outside the park (other than collaborating on landscape-wide water and conservation committees), but they should actively engage in maintaining the areas along the rivers outside the park in as undisturbed a state as possible. Second, clearing should be prioritised along areas in the park that adjoin areas outside the park with a high road density, as this should also minimise the invasion of plants. Although the work also showed that it is ideal to have no roads along the park boundary to help limit invasions, and can provide insight into placement of new roads, work should also be carried out along those areas where there are roads in the park.

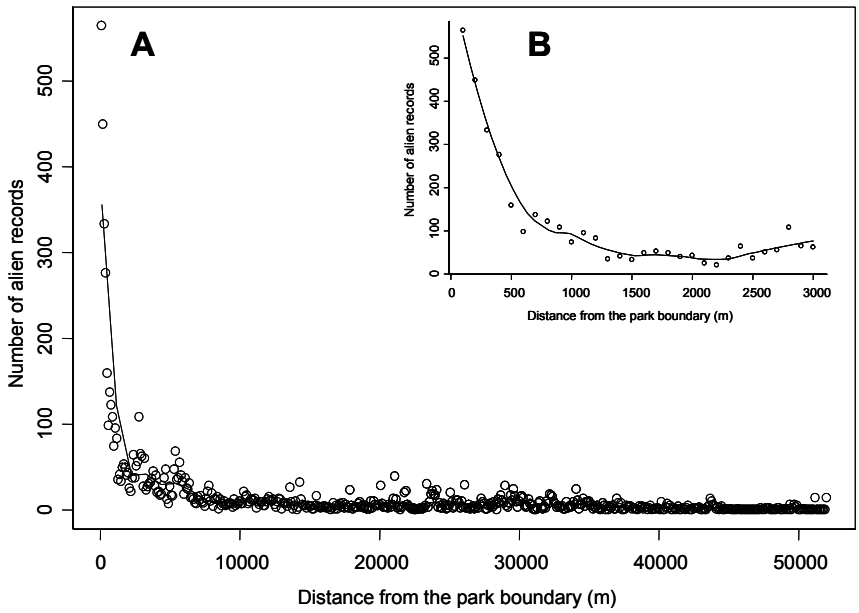


Figure 1. Number of presence records of alien plants relative to the distance from the boundary of Kruger National Park toward the interior of the park: (a) 52,000 m and (b) 3000 m. Fitted curves are LOWESS regression models on square-root number of records (backtransformed for visualization) with no patterns of residuals.

A further significant area has been the investigation of woody shrubs and trees as invasives. Woody plants were not widely considered to be important invasive alien species until fairly recently. Thousands of species of trees and shrubs, however, have been moved around the world. Many species have spread from planting sites and some are now among the most widespread and damaging of invasive organisms. Data collected over more than a decade from the literature and from personal observations by C·I·B core team member Dave Richardson, and Marcel Rejmánek from the University of California, Davis were used to compile a global list of invasive alien trees and shrubs. This was used to explore taxonomic biases, geographical patterns, modes of dispersal, reasons for introductions, and key issues regarding invasions of non-native woody plants around the world. Such information is crucial for improving our ability to plan for the long-term management of woody plant invasions worldwide. The list comprises 622 species (357 trees, 265 shrubs in 29 plant orders, 78 families, 286 genera) (Figure 2). Species introduced for horticulture dominated the list (62% of species: 196 trees, 187 shrubs). The next most important reasons for introduction and dissemination were forestry (13%), food (10%) and agroforestry (7%). 323 species (52%) are currently known to be invasive in only one region, and another 126 (20%) occur in only two regions. Only 38 species (6%) are very widespread (invasive in 6 or more regions). Over 40% of invasive tree species and over 60% of invasive shrub species are bird dispersed. Only between 0.5 and 0.7% of the world's tree and shrub species are currently invasive outside their natural range, but woody plant invasions are rapidly increasing in importance around the world. The objectively compiled list of invasive species produced in this study provides a snapshot of the current dimensions of the phenomenon and will be useful for screening new introductions for invasive potential.

Figure 2. Examples of important invasive trees from different parts of the world. Regions with the largest number of woody invasive alien species are: Australia (183); southern Africa (170); North America (163); Pacific Islands (147); and New Zealand (107).

C. Molecular ecology and genetics of invasions

The main focus of this work remains the molecular ecology of plant invasions. Initially this focus was predominantly on Australian wattles (acacias) and their associated antagonists and/or symbionts. During the past year the scope of research efforts has diversified substantially, not only in terms of the taxa being studied, but also out approaches and research questions. Currently students are focussed on population genetics, phylogeography, molecular systematics and epi-genetics. Key outputs during 2011 include a substantial amount of work on the molecular ecology of Australian acacias. This body of work formed part of a special issue in the journal *Diversity and Distributions*.

An important gap in the invasion ecology of leguminous species is how they influence and are influenced by soil microbe communities and interactions through biological nitrogen fixations. While these are complex issues to address a good starting point is a comparative analysis of symbiotic bacterial diversity between native and invasive legume populations. Rodríguez-Echeverría *et al*. (2011, *Divers. Distrib.*) made an intercontinental comparison of invasive (Portugal and South Africa) and native (Australian) acacias and their rhizobial symbionts. This work indicated that above-ground invasions (plants) may, in some instances, be facilitated by introductions of obligate symbionts (nitrogen-fixing bacteria) from the introduced range (Figure 3).

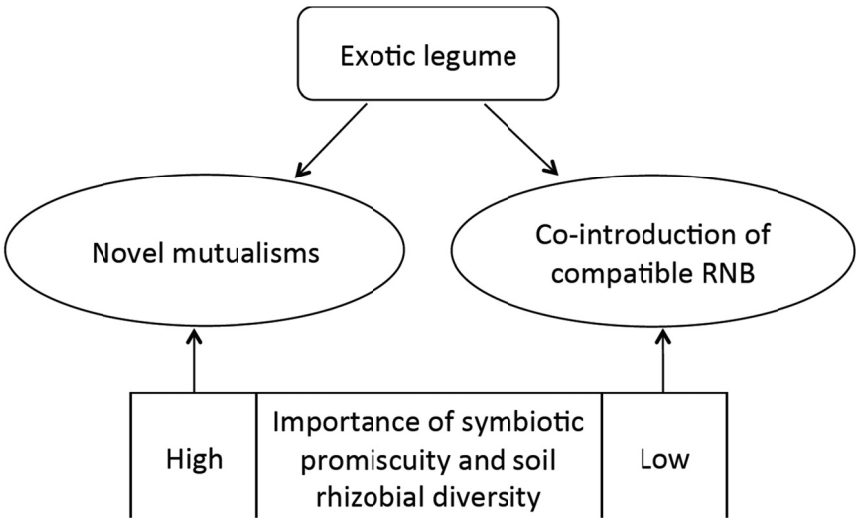


Figure 3. Strategies of exotic legumes for nodulating in new regions. RNB = root-nodulating bacteria. From: Rodríguez-Echeverría *et al.* (2011 *Divers. Distrib*.).

Genetic techniques are increasingly being used as a tool for assessing aspects of species' introduction histories, native sources and evolutionary potential in the introduced range. Again, Australian acacias provide an interesting case study, as their introduction histories to South Africa are extremely well documented. Le Roux *et al*. (2011, *Divers. Distrib.*) studied the phylogeographic consequences of introduction histories of different Australian acacias to South Africa. They found that the link between gene structure, mode of introduction and propagule pressure is not always as straightforward as is generally assumed in the literature.

Molecular approaches can also be useful to understand better the evolutionary mechanisms underlying invasion success. Thompson *et al.* (2011 *Divers. Distrib.*) correlated intra-specific genetic variation between different 'subspecies' of *Acacia saligna* with bioclimatic niche preferences. This study was among the first to make a link between genetic structure and bioclimatic affinity of an invasive species. The study showed that intra-specific genetic entities ('subspecies') of *A. saligna* occupy distinct bioclimatic niches in Western Australia. This has very important implications for management of the species in regions where it has become invasive, since different genetic entities are known to have been introduced to different parts of the world.

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

The C·I·B's work on global environmental change drivers, and particularly interactions among them, is continuing to develop. Because of the numerous threats posed by invasive species to natural ecosystems, a major goal of invasion biology is to understand the factors explaining the distribution of species worldwide. Despite the many efforts at local and regional scales to predict areas vulnerable to invasion, the relative roles of biotic and abiotic conditions on the global distribution of species are still rather poorly understood. C·I·B scientists, together with an international team of researchers, examined the global

distribution of one of the world's most widespread and best-studied invasive species, the Argentine ant (*Linepithema humile*) (Roura-Pascual *et al*. 2011. *PNAS*). This study was the first to investigate the combined effect of key determinants of invasion (climate, resistance from native ant fauna, and human influence) on the global distribution of this notorious invasive species. The results highlight that climate and human modification of habitats play crucial roles in determining the worldwide distribution of the Argentine ant. Temperature and humidity are known to constrain the occurrence of the species in favourable climates in Mediterranean and subtropical regions around the world, allowing the species to establish and spread. This capacity of the Argentine ant to occupy new territories is also favoured by human influence. Areas with more influence of humans are more susceptible, as they receive more introductions. Another reason is that areas with dense concentrations of humans are more likely to have favourable microclimates for the establishment of viable populations (such as greenhouses or watered gardens) in habitats that without human influence would be unsuitable. It has long been speculated that the presence of closely-related native ants could also be a factor in shaping the global distribution of the Argentine ant, since competitive ants are known to constrain the range of the species in some areas. This study was the first to incorporate this factor in a global model of an invasive species. Sites with more closely-related ants tended to have less chance of being invaded. The influence of this biotic resistance was more important in areas with less suitable climates and moderate degrees of human modification. However, though the presence of related taxa may hinder invasion, there is little evidence that native ants preclude the establishment of populations of the Argentine ant, particularly if the climate is suitable and human pressure on the environment is high. The main message from this study is that climate and human modification of habitats interact to shape the global distribution range of the Argentine ant. Human activity clearly influences the movement and establishment of species, but climate suitability is the ultimate constraint on the distribution of this invasive species. These results suggest some management practices that could potentially slow the spread of Argentine ants in some regions. For example, 'xerigardening' or 'xeriscaping', involving the use of drought-resistant garden plants that require little or no irrigation during summer, could greatly reduce the suitability of some regions for Argentine ant establishment and spread. On the other hand, plant species that provide food for ants or the many species that have extrafloral nectaries should be avoided. It is at this local ('in my backyard') scale that the last opportunity to reduce the global spread of Argentine ants exists.

The Centre has also been instrumental in understanding the likely impacts of climate change on ectotherms. First, in a landmark study we recognized that determining organismal responses to climate change is one of biology's greatest challenges (Clusella-Trullas *et al*. 2011 *Am. Nat*.). Recent forecasts for future climates emphasize altered temperature variation and precipitation, but most studies of animals have largely focused on forecasting the outcome of changes in mean temperature. Theory suggests that extreme thermal variation and precipitation will influence species performance and hence affect their response to changes in climate. Thus, we used an information-theoretic approach to show that in squamate ectotherms (mostly lizards and snakes), two fitness-influencing components of performance, the critical thermal maximum and the thermal optimum, are more closely related to temperature variation and to precipitation, respectively, than they are to mean thermal conditions. By contrast, critical thermal minimum is related to mean annual temperature. Our results suggest that temperature variation and precipitation regimes have had a strong influence on the evolution of ectotherm performance, so that forecasts for animal responses to climate change will have to incorporate these factors and

not only changes in average temperature. These results also led us to question the general outcome of two high profile papers on climate change-related extinctions in ectotherms. First, we showed using the thermal safety margin concept that species in the strictly tropical regions might not necessarily be most at risk as previously suggested (Figure 4), but that species just outside the tropics might be most at risk.

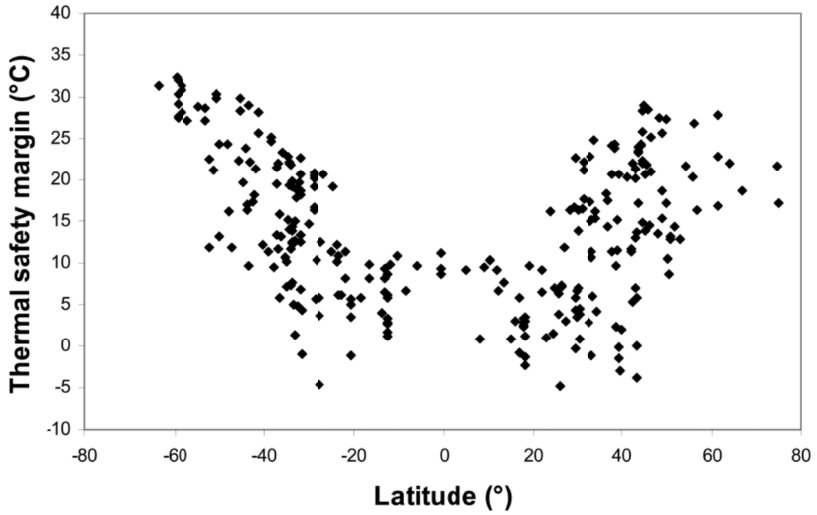


Figure 4. The thermal safety margin indicates the species most at risk from climate change with low margins meaning most risk. The highest risk areas lie just outside the tropics (see Clusella-Trullas *et al*. 2011 *Am. Nat*.).

In the second case, using a regionally calibrated model, Sinervo *et al.* (*Science* 2010) predicted potential climate change impacts on lizard populations and estimated that many extinctions are under way. We argued that because of skew in environmental temperatures and variation in their variance, this model is not sufficient for predicting global losses in lizard species in response to anthropogenic climate change (Clusella-Trullas & Chown 2011 *Science*).

Two studies by Centre members have changed current perspectives on ecosystem services. The first deals with *Prosopis spp*., invasive leguminous trees that cover at least 18 000 km^2 of the low-lying alluvial plains and seasonal watercourses in the Nama Karoo. Indigenous to North and Central America, they were introduced to South Africa for shade, fodder and firewood in the late 1880s. Sparse stands provide a net benefit to farmers, but once the invasions have coalesced into dense, impenetrable thickets, they suppress and displace native forage species and reduce grazing capacity. Ndhlovu *et al*. (2011, *Afr. J. Range Forage Man.*) quantified the impact of *Prosopis* invasion and clearing on rangeland composition and grazing capacity in the Nama Karoo. They found that invasion (c. 15% *Prosopis* canopy cover) reduced grazing capacity by 34%, whereas clearing improved it by 110% within six years. Much of the loss in grazing capacity during invasion was due to the displacement of an annual grass that dominated herbaceous forage production at the study site. Improvement in rangeland grazing capacity after *Prosopis* clearing was due to increases in abundance and establishment of annual and perennial grasses. Grazing capacity in cleared rangeland was 39% higher than in uninvaded rangeland due to a higher

abundance of annual and perennial grasses. While *Prosopis* invasion can lower grazing capacity in Nama Karoo rangeland, clearing *Prosopis* from such rangeland can, even under heavy grazing, substantially improve grazing capacity within 4–6 years.

The second case has to do with ecosystem functioning in the Fynbos Biome. Previous studies in the biome have suggested that biological decomposition rates in the fynbos vegetation type, on poor soils, may be so low that fire is the main factor contributing to litter breakdown and nutrient release. However, the Fynbos Biome also comprises vegetation types on more fertile soils, such as the renosterveld. The latter is defined by the shrub *Elytropappus rhinocerotis*, while the shrub *Galenia africana* may become dominant in overgrazed areas. Together with collaborators from abroad, Centre Researchers examined decomposition of litter of these two species and the geophyte *Watsonia borbonica* in patches of renosterveld in an agricultural landscape (Bengtsson *et al*. 2011 *Oecologia*). In particular, the aim was to understand how plant species identity affects litter decomposition rates, especially through variation in litter stoichiometry. Decomposition (organic matter mass loss) varied greatly among the species, and was related to litter N and P content. *Galenia africana*, with highest nutrient content, lost 65% of its original mass after 180 days, while *E. rhinocerotis* had lost ca. 30%, and the very nutrient poor *W. borbonica* <10%. Litter placed under G. Africana decomposed slightly faster than when placed under *E. rhinocerotis*. Over the course of the experiment, *G. africana* and *E. rhinocerotis* lost N and P, while *W. borbonica* showed strong accumulation of these elements. Decomposition rates of G. africana and *E. rhinocerotis* were substantially higher than those previously reported from fynbos vegetation, and variation among the species investigated was considerable. These results suggest that fire may not always be the main factor contributing to litter breakdown and nutrient release in the fynbos biome. Thus, biological decomposition has likely been underestimated and, along with small-scale variation in ecosystem processes, would repay further study. Further work in fynbos vegetation has revealed similar trends and will be published in 2012.

At a more general level, Australian acacias or 'wattles' (1012 recognized species native to Australia, previously grouped in *Acacia* subgenus *Phyllodineae*) have been moved around the world by humans over the past 250 years, creating the opportunity to explore how evolutionary, ecological, historical and sociological factors interact to affect the distribution, usage, invasiveness and perceptions of a globally important group of plants. Much work on this genus by Centre researchers and their colleagues, published as a special issue of the journal *Diversity and Distributions*, was framed in the context of a unified framework for biological invasions (Blackburn *et al*. 2011 *Trends Ecol. Evol.*). Distributions of species were mapped across Australia, their representation in bioclimatic zones examined, and the potential global distribution of the group modelled. By collating a variety of different lists researchers determined which Australian acacias have reached different stages in the introduction-naturalization-invasion continuum in different parts of the world. Paradigms and key research questions that underpin the current understanding of issues relating to salient barriers, stages, and management perceptions were sketched. The global database of Australian acacia records that was compiled for the special issue showed that 386 species (more than a third of the group) have been moved outside Australia by human agency, 71 species have been described as naturalized or weedy, and 23 can be unequivocally categorised as invasive. Climatic models suggested that about a third of the world's land-surface is climatically suitable for Australian acacias. Many species are commercially important crops or are useful for other purposes and have been extensively planted, and many different human perceptions of Australian acacias exist in

different parts of the world. The papers in the special issue covered all of the barriers, stages, and processes that define biological invasions and touch on many aspects: history and the human dimension; aspects of the species pool; species traits; biotic interactions; climate and niche; and management. The work has shown that Australian acacias are an excellent model group for examining interactions between evolutionary, ecological and socio-economic drivers of species introductions. This work has shed new light on the biological, ecological and evolutionary correlates of naturalization and invasion, but showed that human usage factors permeate all explanatory models. Insights from numerous perspectives are summarized in Figure 5.

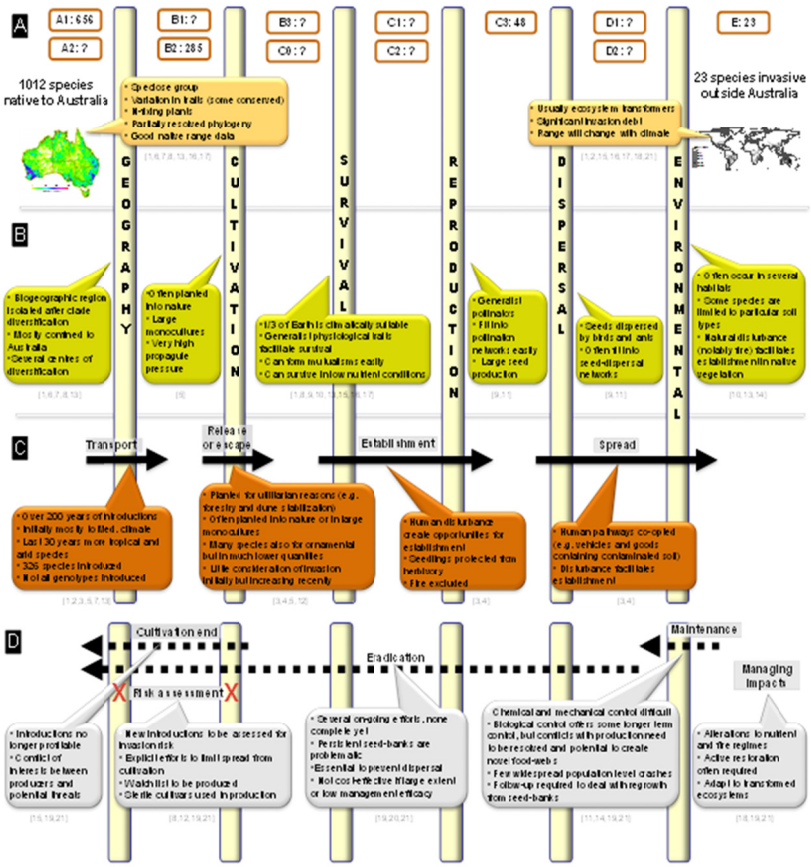


Figure 5. Insights from a multi-disciplinary study on human-mediated introductions of Australian acacias around the world. The four horizontal panels summarize: A) The number of species in each introduction category; B) The biotic and abiotic barriers to invasion; C) The role of humans in facilitating Australia acacia movements and invasions; D) Management actions and options. Adapted from Richardson *et al*. (2011; *Diversity Distrib*.).

The Centre has also focussed on developing other theoretical areas by exposing them to empirical tests. Although theory underlying the invasion paradox, or the change in the relationship between the richness of alien and indigenous species from negative to positive

with increasing spatial scale, is well developed and much empirical work on the subject has been undertaken, most of the latter has concerned plants and to a lesser extent marine invertebrates. Centre researchers and colleagues examined the extent to which the relationships between indigenous and alien species richness change from the local metacommunity to the interaction neighbourhood scales, and the influences of abundance, species identity, and environmental favourability thereon, in springtails, a significant component of the soil fauna (Terauds *et al*. 2011 *Ecology*). Using a suite of modelling techniques they showed that the abundance and species richness of both indigenous and alien species at the metacommunity scale respond strongly to declining environmental favourability, represented by altitude. Consequently, alien and indigenous diversity covary positively at this scale. By contrast, relationships are more complex at the interaction neighbourhood scale, with the relationship among alien species richness and/or density and the density of indigenous species varying between habitats, being negative in some, but positive in others. Additional analyses demonstrated a strong influence of species identity, with negative relationships identified at the interaction neighbourhood scale involving alien hypogastrurid springtails, a group known from elsewhere to have negative effects on indigenous species in areas where they have been introduced. By contrast, diversity relationships were positive with the other alien species. These results are consistent with both theory and previous empirical findings for other taxa that interactions among indigenous and alien species change substantially with spatial scale and that environmental favourability may play a key role in explaining the larger scale patterns. However, they also suggest that the interactions may be affected by the identity of the species concerned, especially at the interaction neighbourhood scale.

E. Detection, deterioration, restoration, reintroduction

The management of invasive alien plants in South Africa can often be characterised as reactive, as has been shown by some Centre researchers (e.g. van Wilgen *et al.* 2011 *Divers. Distrib*.). However, the ability to control an infestation, and restore the functions is heavily dependent on the age of an infestation (shown by Centre researchers and collaborators, Le Maitre *et al*. 2011 *Divers. Distrib.*). In particular, large seed-banks develop over several years leading to long-term population persistence and severely limiting options for restoration.

Global experience in managing Australian acacias was reviewed as part of the Centre's on-going work in the area. While there are species and site differences the difficulties experienced by managers are the same (Wilson *et al*. 2011 *Divers. Distrib.*). The large persistent seed-banks makes control incredibly difficult, and there are few effective methods for reducing such seed-banks over large areas. Moreover, the general characteristics of Australian acacias means that, providing the climate is suitable, they will fail pre-border risk assessments and will likely become high impact invaders. The other main finding, in both this and a related paper by Centre members (Richardson *et al*. 2011 *Divers. Distrib.*) was the tight relationship between the extent of planting and invasion success. All species with a long and extensive history of planting have become invasive somewhere, suggesting that, indeed, Australian acacias, as a group, have a high risk of becoming invasive (Gibson *et al*. 2011 *Divers. Distrib.*) and causing significant impacts (Le Maitre *et al*. 2011 *Divers. Distrib.*). These projects have provided important practical recommendations on approaches for managing future infestations. In particular classical biological control agents that have a successful track-record in South Africa should be used to mitigate existing widespread invasions, and seed-feeding biological control agents can be used pro-actively to limit spread from commercial plantations. But most importantly

results from the extensive work on diverse aspects relating to Australian acacias as introduced species stress the crucial role of pro-active management - the eradication of small naturalising populations before they build up large seed-banks, spread widely, and before impacts build up. The work has provided the rationale for the eradication management plans being developed in collaboration with the South African National Biodiversity Institute for *Acacia implexa*, *A. paradoxa* and *A. stricta*. While these recommendations are general in nature, specific matters relating to *Acacia paradoxa* management in South Africa are also considered. Together with colleagues from Australia, a management decision model was built to determine under which conditions eradication is the most cost-effective option, how much eradication is likely to cost, and how much effort should be invested in determining the precise current extent before the decision to implement eradication is made (Moore *et al*. 2011 *Divers. Distrib*.). It was found that over the next 20 years, given the environmental and management costs and the current infestation size of 310 ha, the optimal management strategy for *A. paradoxa* is eradication, and is estimated to cost ZAR 8 million. Indeed, more generally infestations of up to ~750 ha should be targeted for eradication. The major caveat, however, is that the estimate of the current infestation extent is reliable. If the estimated extent is not reliable then eradication should only be considered for much smaller estimated extents ~300 ha. The cost of reducing the uncertainty in extent can therefore provide a significant benefit in terms of eradication and management decision. The other major finding in the paper was how the value of learning (which can be expressed in ZAR terms) varies with current extent. If infestations are obviously very small or very large, the management decision is not improved by further survey work. However, the closer an infestation is to a decision threshold (e.g. between eradication and containment), the more valuable is research to determine the precise extent (i.e. money spent making a more informed decision will save money in terms of making the most cost-effective decision; in the *A. paradoxa* this was up to 8% of total control costs).

As critical ecosystem services continue to decline at alarming rates and levels, it is expected that active restoration (the process of repairing these impacted ecosystems, with the main goal of bringing them back to some level of health, integrity and self-sustainability) will play an increasingly important role in the future. To become an effective applied science, to compete for limited funding and to be adaptive, it must become evidence based. Using a literature review and an online survey, Centre Researchers (Ntshotso *et al*. 2011 *Restor. Ecol.*) reviewed 10 restoration programs in South Africa to assess whether current restoration practice meets the conditions of evidence-based restoration, namely: (1) collection of baseline information; (2) setting clearly defined goals; and (3) relevant and adequate monitoring. The review showed good collection of baseline information and the setting of restoration goals that span ecological and socioeconomic considerations. However, to a large extent goals were poorly defined, there was more monitoring of inputs than outcomes, and monitoring of ecological indicators was inconsistent. These shortcomings can undermine restoration impacts, as well as the future sustainability of these expensive programs. This paper has already generated some interest, with a response article and rebuttal already available through the journal.

F. Risk assessment indicators and policy

Worldwide, realization is growing that protected areas are part of a complex social-ecological system characterised by flux, non-linear relationships and unpredictable outcomes. The management of such areas needs to be adaptive, to accommodate changing ecological understanding and societal values, and to deal with unexpected events. Adaptive

management requires ongoing cycles of goal-setting, monitoring, evaluation and change. While the concept of adaptive management is gaining support, there are few examples of where it has been implemented within a well-defined framework of objectives. Adaptive management approaches have been developed and implemented in the Kruger National Park (KNP) for over 15 years, and selected management topics were used as the basis for a critical assessment of the implementation of adaptive management in the KNP (van Wilgen *et al*. 2011 *Biol. Conserv.*). The purpose was to identify broad lessons arising from more than 15 years of experience in the development and application of adaptive management over a large area. The study showed that adaptive management has identified important issues with regard to biodiversity conservation, and resulted in a shift in management focus, away from less important issues, to the more important issues. Because the conservation outcomes of management shifts will only manifest themselves in the longer term, the relative success of adaptive management should be measured by the degree to which management has been refocused onto priority issues, and by the rate at which new understanding is generated. Some issues previously seen as important (fire, rare antelope), are now regarded as less so, while others remain important and difficult to solve, although there has been some progress (rivers, alien plants and elephants). The experience gained in the KNP has also been used to expand adaptive management to other protected areas. The development and use of adaptive approaches to manage fire in the Table Mountain and Bontebok National Parks was reviewed and the degree to which these approaches have impacted on the conservation of biodiversity were recently assessed by Centre researchers and collaborators (van Wilgen *et al*., *Koedoe*). One of the major challenges in ecosystem management that we identified was the inability of managers to predict the outcomes of their management interventions in the longer term. Fire management interventions, ultimately, will manifest themselves in terms of biodiversity outcomes, but definite links between fire interventions and biodiversity outcomes have yet to be made. This is a common problem in ecosystem management, and one that adaptive management was designed to address.

Strategic adaptive management was also the focus of a recent special issue of the journal *Koedoe* edited by colleagues Dirk Roux (SANParks) and Llewellyn Foxcroft (SANParks and a C·I·B core team member). The foundations of 'adaptive environmental assessment and management' have now grown into an established field of research and practice, with a rich base of theoretical literature relating the merits of adaptive management. Unfortunately implementation has failed to some extent in many instances, indicating the challenges of integrating these theoretical advances into practice. From its tentative foray into elements of adaptive management, SANParks' version of adaptive management has evolved into what is termed 'strategic adaptive management', emphasising forward-looking aspects. The special issue discusses a wide range of learning experiences, documenting the history, evolution and proposed future develop. Strategic adaptive management is also an appealing approach for alien species management and is rapidly gaining support, but as experienced elsewhere, implementation remains problematic. Although a number of elements of an adaptive management system have been developed for alien species management in SANParks, most of these have been in isolation and in many cases ineffectual (Foxcroft & McGeoch 2011 *Koedoe*). These include long-term objectives, thresholds of potential concern, park management plans and annual alien species clearing plans. A glaring omission was the need for a comprehensive list of alien species across the national parks to use as a basis for monitoring and management interventions. Spear *et al*. (2011 *Koedoe*) worked through all available publications, reports, management plans and personal communications with park managers and

ecologists to develop a list of 672 verified species. In order to integrate the varied components of the management system, Foxcroft & McGeoch (2011 *Koedoe*) developed a framework in which to embed each element, to promote collaborative efforts and continuous feedback loops. This largely includes the park management plan, informed by the organisational and park specific objectives and including the alien species clearing plans, a science-management forum within which to discuss issues of common interest, and a monitoring programme.

Much work in this area of the Centre's research interests also focussed on Antarctica. The Antarctic continent is frequently cited as the last pristine continent on Earth. However, this view is misleading for several reasons. First, there has been a rapid increase in visitors to Antarctica, with large increases at research bases and their environs and to sites of major tourist interest (e.g. historical sites and concentrations of megafauna). Second, although substantial efforts are made to avoid physical disturbance and contamination by chemical, human and other wastes at these sites, little has been done to prevent the introduction of non-indigenous microorganisms. Together with colleagues, Centre researchers analysed the extent and significance of anthropogenic introduction of microbial 'contaminants' to the Antarctic continent (Cowan *et al*. 2011 *Trends Microbiol*.). The group concluded that such processes are unlikely to have any immediate gross impact on microbiological community structure or function, but that increased efforts are required to protect the unique ecosystems of Antarctica from microbial and genetic contamination and homogenisation.

Data from food contaminants illustrated that risks from some pathways may be high. In the Antarctic region, importation of fresh produce is a potentially high risk, but was until the recently an unquantified pathway. To address this knowledge gap, >11,250 fruit and vegetables sent to nine research stations in Antarctica and the sub-Antarctic islands, were examined for associated soil, invertebrates and microbial decomposition (Hughes *et al*. 2011 *Biol. Conserv*.) (Figure 6). Fifty-one food types were sourced from c. 130 locations dispersed across all six of the Earth's inhabited continents. On average, 12% of food items had soil on their surface, 28% showed microbial infection resulting in rot and more than 56 invertebrates were recorded, mainly from leafy produce. Approximately 30% of identified fungi sampled from infected foods were not recorded previously from within the Antarctic region, although this may reflect limited knowledge of Antarctic fungal diversity. The number of non-native flying invertebrates caught within the Rothera Research Station food storage area was linked closely with the level of fresh food resupply by ship and aircraft. We concluded by presenting practical biosecurity measures to reduce the risk of non-native species introductions to Antarctica associated with fresh foods. These have been presented to the Antarctic Treaty.

Finally, despite the recognised importance of intra-regional propagule transfer, the majority of studies have focused on inter-regional pathways (i.e. from outside of the Antarctic region). Centre researchers quantified the number of seeds carried by expeditioners who have visited sub-Antarctic Marion Island. We recorded 420 seeds from 225 items of clothing, with seeds found on 52% of the items and soil on 45% of them. The median number of seeds for field-based and station-based personnel was 20.5 and 3 per person, respectively. Waterproof trousers and socks, particularly those of field workers, carry the greatest number of propagules (for field workers, medians of 5 and 6.5, respectively) and therefore should be the focus of intra-regional management interventions. Amongst the seeds found entrained within clothing several were from species which are

widespread aliens in the Antarctic region including *Agrostis stolonifera*, *Poa annua* and *Sagina procumbens*, and indigenous zoochorous species (*Acaena magellanica*, *Uncinia compacta*) were also well represented. The present data provide quantitative evidence in support of previous, largely hypothetical concerns about the risks of intra-regional propagule transfer in the Antarctic.

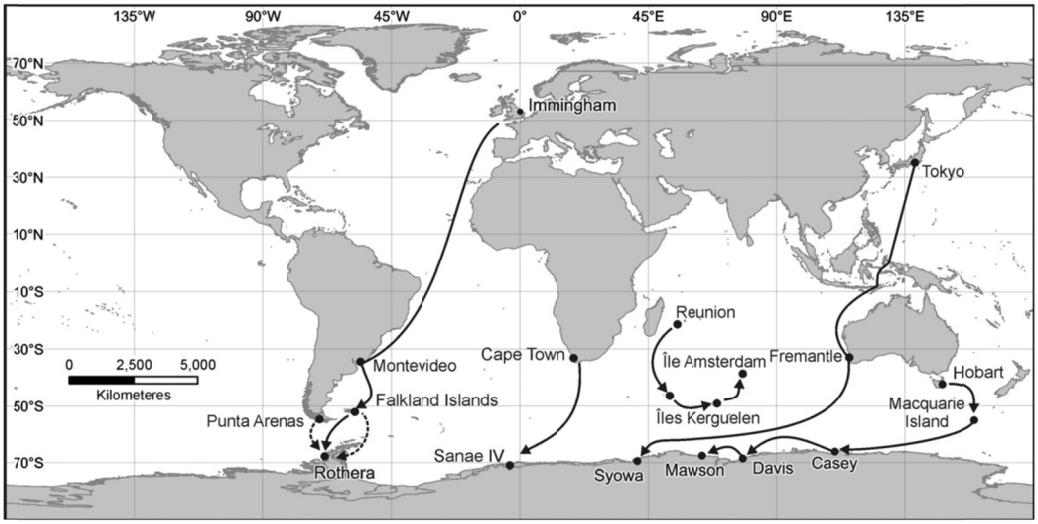


Figure 6. Food transport routes to Antarctica and its surrounding islands sampled in a recent study by Hughes *et al*. (2011 *Biol. Conserv*.).

G. Invasions, science and society

Invasive alien plants often have beneficial uses, and these species can be the most difficult to deal with in terms of agreeing on their control. Good examples of these conflict species include pines (*Pinus* species, which are the basis of the plantation forest industry in South Africa), mesquite (*Prosopis* species, which has value as a fodder and firewood plant), Australian wattles (*Acacia* species, which have commercial, timber and firewood value), and jackarandas (*Jacaranda mimosifolia*, which has iconic aesthetic value). Thus, these species impact negatively on some services, and positively on others, and trade-offs between services require investigation. Work by Centre member Brian van Wilgen and colleagues has focused on two of these groups: Australian *Acacia* species, and northern-hemisphere *Pinus* species. Australian *Acacia* species are used as a model group to develop a national-level strategies for managing invasive alien plants that both have value and do harm (van Wilgen *et al*. 2011 *Divers. Distrib.*). Invasive Australian *Acacia* species have been widely planted in South Africa for a range of purposes, and they continue to spread and cause undesirable impacts, despite a considerable investment into management. This is because the various practices have historically been uncoordinated in what can best be described as a strategy of hope. Fourteen management practices were identified that could be strategically combined to achieve strategic goals for each of 8 species categories in five discrete regions of the country. When used in appropriate combinations, the prospect of achieving the strategic goal will be maximised. As the outcomes of management cannot be accurately predicted, it was proposed that the management of these species must be

adaptive, and will require continuous monitoring and assessment, and re-alignment of goals if necessary. The proposed strategy offers the best possible chance of achieving goals, and it is the first to address invasive alien species that have both positive value and negative impacts. In the case of *Pinus* species, the work has highlighted some major challenges to the management of protected areas adjacent to pine plantations, and severely invaded by pine trees. These challenges include continual invasion of fynbos by fire-propagated alien pines sourced from plantations; and inadequate resources to redress the 'invasion debt' caused by the socioeconomic legacy and past management neglect (Kraaij *et al*. *S. Afr. J. Sci.*). An argument has also been made (Hoffmann *et al*. *Afr. Entomol.*) that a suspended research project on the potential biological control of pines (which was discontinued in 2009) should be resurrected in the light of escalating negative consequences of pine tree invasions, especially in the Cape Floral Region.

As is clear from the above, people's interactions with invasive alien plants are diverse and dependent on the complex outcomes of historically and geographically contingent processes that integrate plant ecology, economic development, political context and culture. Combined, these factors shape perceptions, contemporary uses and reactions to the plants. Kull *et al.* (2011 *Divers. Distrib.*) examined the various uses and perceptions of introduced Australian acacias by rural communities around the world. They proposed a conceptual model to explain current uses and perceptions of introduced acacias and noted that economic conditions play a key role shaping the use of acacia in different systems. While poorer communities rely on resources generated by acacias for household needs and income, middle-income regions more typically invest in them for commercial purposes. This may be the source of conflict when eradication or control is proposed, however in the search for workable solutions that balance multiple interests; there is scope for different regions to learn from experiences elsewhere in the world.

2 Education and training

2.1 Objectives

Scientific capacity building forms a central component of the business of the C·I·B. Recognising the urgent requirement for improving the demographic, gender and age profiles of the South African scientific community, and for retaining excellence in the science system, the C·I·B supports students at undergraduate and 4th year level, as well as Masters and doctoral level, and post-doctoral associates. The main objective of this performance area is to draw students and young researchers into the Centre's sphere of influence and to encourage them to think about the research done by the Centre as a rewarding career path.

At undergraduate level this is done primarily through the Biodiversity Conservation Academy, run in conjunction with Centre of Excellence for Birds as Keys to Biodiversity.

Much of the research undertaken by the Centre takes place via student training at the post-graduate level. External grants, contracts and donations allow the C·I·B to leverage 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

2.2.1 Post-graduate student achievements

In total, 74 students were supported at post-graduate level. Eighteen of these students completed their studies in 2011 (five B.Sc. (Honours), nine Masters and four Ph.D. students). The high quality of student work was recognized, with Candice-Lee Lyons (Ph.D. candidate) being awarded the prize for the best student presentation at the Zoological Society of Southern Africa meeting held in Stellenbosch, and Alexis Olds (M.Sc. candidate) winning the prize for the best oral presentation by a Masters student at the Southern African Society of Aquatic Scientists conference for her paper titled: 'The potential impact of freshwater fish introductions on a South African wetland of international importance, the Wilderness Lakes System, Western Cape'.

2.2.2 Biodiversity and Conservation Academy

The Biodiversity and Conservation Academy sponsored by the Department of Science and Technology for 2009-2011 was held in January 2011. Fourteen students and interns participated from seven universities (Universities of KwaZulu-Natal, Venda, Free State, Limpopo, Stellenbosch, Walter Sisulu University and Rhodes University) and two public entities (SANBI and SANParks/CREW) (Figure 7). The Academy covered several aspects of biodiversity estimation and the statistical methods required to verify that surveys are adequate. The field project undertaken by groups of students commenced with surveying plant diversity in invaded, uninvaded and cleared stands in De Hoop Nature Reserve to understand the impacts of invasive alien species on plant richness and abundance and understand scaling effects on abundance-occupancy relationships. Particular attention was paid to the impacts of spatial scale on assessing abundance and occupancy and the relationships among them. Students were expected to use the theoretical work in these sections to design field surveys and to identify problematic areas in such surveys. These included taxon identification, estimation of a realistic sample unit size, and techniques to test theoretical concepts using the field surveys.

The second theoretical section covered the assessment of bird populations and the relationships between population viability and the numbers of breeding pairs versus birds not holding territories. African Black Oystercatchers *Haematopus moquini* were used as the exemplar taxon, and long-term data collection methods were discussed. The latter was supplemented by a talk on bird atlassing and the value of good curation of data and long-term data sets. This talk meshed nicely with a second session on the environmental change drivers that are influencing southern African systems and the extent of change being wrought to biodiversity. The practical field work for this section concerned estimation of bird population parameters (numbers, numbers of chicks, food resources) in oystercatchers. Students were shown the basics of bird ringing and morphometric measurement and were also introduced to aspects of invertebrate sampling. In the evenings, ample opportunity was provided for students to enquire about the conservation science system in South Africa, career choices and the requirements for becoming a successful researcher both locally and abroad.

Figure 7. Some of the participants in the 5th Biodiversity Conservation Academy, De Hoop Nature Reserve, January 2011.

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 Outreach 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

A total of 120 peer-reviewed publications in journals, 22 book chapters on a range of topics (see Section 8.2 for details) and 3 books were produced during 2011. Three journal articles appeared in very high impact journals (*Science*, *PNAS*, *Ecology Letters*). A total of

88 oral and poster presentations were given at national and international conferences (Section 8.7) including seven invited keynote or plenary addresses.

The C·I·B hosted the 7th Scientific Committee on Antarctic Research History Workshop at Stellenbosch University in July 2011. Along the theme of 'Antarctic History: Probing the Unknown', workshop attendees from ten countries reflected on current historical and archaeological research being done on Antarctica. "The workshop was an opportunity for South African and international academics to discuss and critically evaluate how historians with Antarctic interests can most fruitfully use the growing accessibility of diverse source material to further research," said Dr. Cornelia Luedecke, who chairs the SCAR History committee. Workshop attendees noted the successful efforts by the Antarctic Legacy Project to provide online archival databases containing the history of South African research endeavours in the Southern Ocean and Antarctic territories over the past six decades. An online database is being compiled that includes oral, visual and tangible memories of the thousands of men and women who have worked in these cold regions over the years as part of, among others, the South African National Antarctic Programme (SANAP).

3.2.2 Scientific communication with students

Students have been involved in Centre activities through direct interactions with their supervisors, but also through several internship activities hosted over the past year. Owing to the need for strategic planning for the final years of the initial funding period, the Annual Research Meeting did not involve students as is typically the case. However, the 2012 meeting will be focused firmly on students again. The level of communication with students has nonetheless increased as a consequence of a variety of joint activities (such as co-supervisions and joint fieldwork), which now form a mainstay of the Centre's business.

3.2.3 Communication with partners

Communication with partners has been through a variety of channels, most notably direct communication between Core Team Members and their research collaborators (especially those abroad), and several meetings, including the Annual Research Meeting held for the first time in Pretoria in 2011. The main aim of the change in venue was to improve exposure of the C·I·B's activities to partner organizations in the Gauteng and Limpopo regions, and this was achieved. The meeting was graciously hosted by the University of Pretoria that has co-invested in the Centre's business and was most welcoming of our activities on campus. Holding the meeting in Pretoria drew in attendance from various government departments and public entities, including the Department of Environmental Affairs and SANParks.

3.2.4 Communication with the public

C·I·B home page

The C•I•B web pages averaged about 67 hits per day during 2011. The monthly figures ranged from 1079 in April to 2032 in October. News articles ('nuggets') were regularly posted to the home page, providing up to date information on research and student training achievements in the Centre (see http://academic.sun.ac.za/cib/news.asp for details).

Iimbovane Outreach Project

The Iimbovane Outreach Project flourished in 2011, completing three outreach visits to partnership schools, two learner workshops, exhibits at educational expos and the facilitation of several educator workshops.

During March 2011 school visits took place, during which the learners received lessons on biodiversity, the importance of long term monitoring, and the scientific method, before they performed their own scientific investigations at research sites on their school grounds. During the second outreach visit in August 2011 learners developed the skills to interpret and present biological data. The project team also used this opportunity to present each Iimbovane school with a multimedia projector which can be used in combination with previously donated laptops and stereomicroscopes. The impacts of the projectors were immediately visible in the excitement of the educators. Mr. Tommy Botha, WCED Senior curriculum planner for FET Life Sciences, expressed his appreciation to the project for providing the schools with equipment that will make a difference to the quality of teaching. "In this digital age, no biology class can be without a data projector. From the WCED side, we are thankful towards the project for making it easier for our educators to teach our learners." The equipment was donated by the Centre's corporate funding partners, AfriSam and Rand Merchant Bank Fund.

Besides building capacity in its partnership schools the project staff were also involved in a number of educator development and science outreach initiatives at local and at national level. One of the key achievements of 2011 was Iimbovane's participation in the national science festival, Scifest Africa which was held in Grahamstown (4-10 May). Iimbovane staff presented a workshop called 'Antastic' was very well received and was awarded the prize for the best outreach workshop. The Iimbovane team strengthened their partnership with WCED by facilitating several training workshops. In August, the team was invited to present at the WCED's annual Women in Science Camp 2011 during which the team members promoted careers for women in science among 120 girl learners.

The project team was also invited to present an educator workshop at the Cape Town Science Centre Educator Forum. The main aim was to broaden educators' knowledge of the theory and practice of biodiversity science in a South African context, information about ant diversity and its applications in the classroom. The session was attended by 10 educators from schools in Cape Town area. Also in August, WCED invited Iimbovane to present an interactive biodiversity workshop to 50 Grade 9 learners at the WCED Overberg Science Expo. Iimbovane was also invited to facilitate a workshop at the annual Standard Bank Maties Mathematics and Science Week, which was attended by 22 learners from Plumstead High School in Cape Town. The project continued its cooperation with Stellenbosch University's Institute for Mathematics and Science Teaching (IMSTUS) in the form of training to life science educators from historically disadvantaged communities. To this end, Dorette du Plessis presented a series of lectures as part of the curriculum for the Advanced Certificate of Education (Life Sciences).

BENEFICIARIES

The Iimbovane Outreach Project interacted with direct beneficiaries and with a number of indirect beneficiaries in 2011. Direct beneficiaries were the approximately 1151 Grade 10 life science learners actively involved in the project at 28 schools in the Western Cape. Seventeen of the schools are located in rural areas and eleven in urban areas. Twenty six schools (93%) are located in previously disadvantaged communities. Of the 18 Life

Science educators trained in 2011, 13 (72%) were women and 16 (88%) were from previously disadvantaged communities. Iimbovane's involvement in science outreach initiatives enables it to interact with a large number of direct and indirect beneficiaries (Table 1).

Table 1. Direct beneficiaries[1] and indirect beneficiaries[2] of the Iimbovane Outreach Project in the period under review

Female	Male	African	Coloured	Indian	White	Disabled	Total
Direct beneficiaries							
Schools outreach visits in March, August and October 2011 (learners): [3]							
569	582	534	570		47		1151
Schools outreach visits in March, August and October 2011 (educators):							
13	5	8	8		2		18
Microscope training workshop for learners:							
11	6		17				17
Iimbovane job shadow:							
	3	3					3
Indirect beneficiaries							
Cape Town Science Centre Educator Forum:							
9	1		7		3		10
WCED Science Overberg Expo: [4]							
							50
Volunteers and students:							
3						3	3
Advance Certificate for Education (life sciences):							
10	7	11	6				17
WCED Women in Science camp:							
100							100
Standard Bank Mathematics and Science Week:							
			22				22

A new initiative of Iimbovane is the provision of job shadow opportunities for Grade 10 learners from Iimbovane schools, who are expected to complete a number of days in the workplace for their Life Orientation curriculum requirements. During the 2011 December school holidays the project opened its doors to three learners from one of its full support schools, Luhlaza Secondary School. The job shadow learners assisted researchers and technicians in the Iimbovane ant laboratory. At the end of the week, learners had a better understanding of the skill sets that scientists need to develop and into the working of a real research laboratory.

[1] Direct beneficiaries refer to learners and educators of the 18 Iimbovane full support schools and 10 subscription schools

[2] Indirect beneficiaries include learners, educators and members of the public that interacted with the project at science expos and science festivals, educator forums and at skills development sessions

[3] Demographic data of some participatory schools are outstanding

[4] Demographic data of some indirect beneficiaries could not be established

Maintaining the public profile of the project remains critical to Iimbovane's reputation. In 2011, the project's activities continued to generate interest from the media and the project has been the topic of several radio broadcasts, both nationally and internally. Dorette du Plessis and two Iimbovane educators, Ms. Stears and Mr. Riffel were interviewed by Anthea Adams, on the programme *Ons en die Onderwys*. Brigitte Braschler and Dorette du Plessis were interviewed by Christina Scott on *Science Matters* on SAFM. Ms. Du Plessis was interviewed by Wandile Kallipa, on the international channel, Channel Africa and on Redi Tlhabi's *Green Tip of the Day* on CapeTalk.

Perhaps the most important recognition that the Iimbovane Project received during 2011 was the statement, in a peer-reviewed journal article published in PLoS One. The authors of the article, entitled 'Children prioritize virtual exotic biodiversity over local biodiversity' cited Iimbovane as an example of an effective outreach initiative that is making young people aware of the value of biodiversity. The authors stated "The rarity of educational programs based on both field experience and noniconic animals is particularly unfortunate considering successful initiatives such as the Iimbovane Outreach Project in South Africa that explores biodiversity in school grounds and surrounding natural areas based on ants' ecology and diversity as a mean to connect children to their environment (http://www.sun.ac.za/Iimbovane/index.htm)." (Ballouard *et al.* 2011 *PLoS One*, full article available at: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0023152).

SUCCESS STORY

For some Iimbovane learners, the highlight of the year may have been the Iimbovane Winter Week. In June 2011 the project hosted its annual Iimbovane Biodiversity Winter Week for selected learners from participating schools. The aim of the workshop is to give learners who show a real interest in biological sciences the opportunity to spend a week at Stellenbosch University to learn more about biodiversity and how ecologists use mathematical indices as a means to conserve and manage our biodiversity. Learners attending this workshop offered to act as 'Iimbovane group leaders' back in their own schools and to help their classmates to understand the science behind the project. During the project's schools outreach visit in August 2011 these learners assisted the Iimbovane project team by explaining to their fellow classmates how to analyse and interpret the biological data they collected during a previous session. One learner that took his role as 'Iimbovane group leader' to heart and that deserves special mention is Mkhululi Rotile from the Manzomthombo Secondary School in Blackheath (see photographs below).

Figure 8a. Ms. Bentele (Life Science educator) and Mr. Matiso (Principal) of the Manzomthombo Secondary School in Blackheath accept a data projector from Ms. Dorette Du Plessis (Outreach Manager)

Figure 8b. Learners at the WCED Overberg Science Expo view specimens under the microscope.

Figure 8c. Learners from the Umyezu Wama Apile Secondary School planting pitfalls for the collection of ant species in their school grounds.

Figure 8d. Mkhululi Rotile explaining to his classmates how to calculate biodiversity indices. Mkhululi was one of the learners who attended the Iimbovane Biodiversity Winter Week 2011.

3.2.5 Media highlights

During 2011 the C·I·B's achievements were well reported on in the media. Highlights from media interactions covered themes including Antarctic science, changing environments and invasive species.

Antarctic science

The C·I·B's contribution to Antarctic science was emphasized through several mentions in the media. In September 2011, Prof. Steven Chown was invited to deliver the prestigious S.T. Lee lecture at the Victoria University of Wellington, New Zealand. In his lecture, *Lion griefs in the shade: Global change biology in the Antarctic***,** Prof. Chown stressed the mounting evidence of how climate change affects the Sub Antarctic region. (To listen to the lecture: http://www.victoria.ac.nz/antarctic/about/news/s-t-lee-lecture/lecture-2011.aspx). The lecture was welcomed by the New Zealand media and led to an interview on the national radio station, Radio New Zealand. Information about the lecture and interview was further disseminated on international websites including ABC Rural Australian Broadcasting Corporation, Royal Society of New Zealand, Science Media Centre New Zealand and Australian Antarctic Division. (Access to the interview: http://mediawatch.co.nz/national/programmes/sunday/20110918).

The C·I·B's on-going history project, the Antarctic Legacy Project, attracted much attention in the media after the hosting of the 7th annual meeting of the Scientific Committee on Antarctic Research (SCAR) History Action Group in Stellenbosch. The success of the workshop was publicised through numerous local and international media networks and included articles on international websites including the United States SCAR website and University World News. Dora Scott, programme manager of the Antarctic Legacy Project, was also interviewed on national radio stations including Radio Sonder Grense and Talk Radio 702. Articles about the meeting and the project appeared in the newspapers Saturday Star and Cape Times, Information about the project, supported independently by the DST and NRF, through the South African National Antarctic Programme (SANAP) can be found at: http://academic.sun.ac.za/cib/antarcticlegacy/.

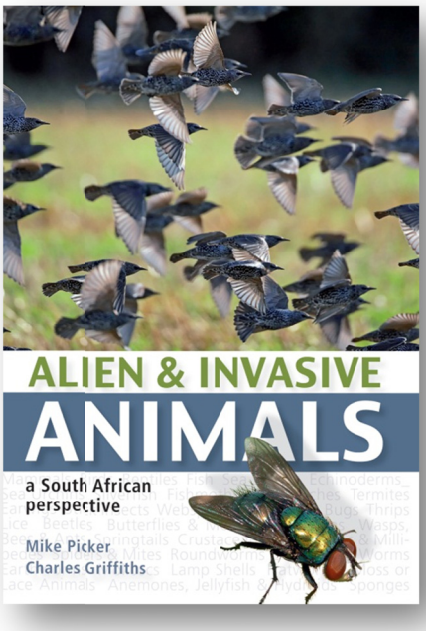
In March 2011 the C·I·B's involvement in the Sub Antarctic region received further media attention with the launch of the new research base on Marion Island. Articles featured in *Die Burger*, *Cape Argus* and *Daily News*. Antarctic research conducted by Dr. Jennifer Lee also attracted the media's attention. Dr. Lee's research, which focussed on the potential risks of the introduction of non-native species through the movement of fresh produce to Antarctica resulted in news articles in the *Saturday Star* and *Sunday Weekend Argus*.

Changing environments

The year 2011 marked the 17th Convention of Parties (COP17) to the UNFCCC and in light of this event the C·I·B generated a great deal of media interest about current climate change projects at the Centre. The C·I·B is undertaking several aspects of work in the area of climate change and its effects on human society, in particular, the possible distribution of insects that act as vectors for malaria and human sleeping sickness and the likely responses of ectotherms to changing temperatures. Award-winning research conducted by Ph.D. candidate, Candice-Lee Lyons, on the African malaria vectors, *Anopheles arabiensis* and *Anopheles funestus*, featured widely in the print media. Articles in *Business Day* and *Daily News* were amongst them. A research paper by Dr. Susana Clusella-Trullas and co-authors, Prof. Steven Chown and Prof. Tim Blackburn, in the journal, *American Naturalist*, led to an online article on the international website *American Society of Naturalists*. (To view the article: http://www.asnamnat.org/node/101)

Invasive species

In November 2011, Prof. David Richardson was honoured by the Royal Society of South Africa when he was named as the recipient of the prestigious John F.W. Herschel Medal for 2012. Prof. Richardson was recognised for his multidisciplinary contribution to science in South Africa through his exceptional work on the ecology of biological invasions and management strategies for invasive species. This achievement by Prof. Richardson was reported in *Die Burger*.



Invasive species are widely recognised as the second-most important human impact on ecological systems, exceeded only by direct habitat destruction. To further the public's understanding of the invasive species in a South African context, C·I·B core team member, Prof. Charles Griffiths, and co-author Prof. Mike Picker published a popular titled, *Alien & Invasive animals — a South African perspective.* The new book was launched in September 2011 and was reviewed in the *Cape Argus*.

Researchers at the C·I·B contributed to two chapters in the second edition of David Pimentel's influential book *Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species* published in May 2011. In the book, the public's attention is drawn to the mechanisms of biological invasion, their subsequent environmental effects, and estimates on the economic costs of these impacts. The book also reiterates the diverse and unpredictable roles that non-native species adopt as they invade new ecosystems.

The complete list of media interactions can be viewed in Sections 8.8 and 8.10.

Knowledge Management System

The C·I·B's Information Retrieval and Submission System (IRSS) now contains a total of 924 items. These include 63 long-term projects datasets; 695 core team member publications; 83 datasets and theses, and 83 post-doc and student outputs.

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

A donation was received from the Drakenstein Trust for student projects on invasive plants from 2012 to 2014. The funds will be used to support two M.Sc. students and a post-doctoral associate working on key species in the Western Cape.

4.2.2 New international agreements

None

4.2.3 New national agreements

None

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

Dr. Irmgard Amrein, University of Zurich, Department of Anatomy & Neurobiology. Collaboration on small mammal biology (Chimimba)

Dr. Galina Azarkina, Institute of Systematics and Ecology of Animals, Russian Academy of Sciences, Russia. Collaboration on jumping spiders (Salticidae) of South Africa: an evaluation of biodiversity and species richness of the country (Foord)

Dr. Anne Bedos, National Museum of Natural History, Paris. Collaboration on springtail systematics (Chown)

Prof. Janne Bengtsson, Swedish Agricultural University. Collaboration on soil diversity (Chown)

Dr. Bethany Bradley, University of Massachusetts. Lecture on impacts of land use and climate change on regional plant invasion: Cheatgrass in the Western U.S. (Richardson)

Prof. Peter Convey, British Antarctic Survey. Collaboration on Antarctic invertebrate phylogeography (Chown)

Prof. Louis Deharveng, National Museum of Natural History, Paris, Collaboration on springtail systematics (Chown).

Dr. Steven M Goodman, Field Museum of Natural History, Chicago, IL, USA and Association Vahatra, Antananarivo, Madagascar. Collaboration on climate change in Madagascar (van Vuuren)

Dr. Kevin Hughes, British Antarctic Survey, Collaboration on Antarctic biosecurity (Chown)

Prof. Vojtěch Jarošík, Department of Ecology, Charles University, Czech Republic. Collaboration on determinants of distribution and spread of alien plants in Kruger National Park (Foxcroft, Richardson)

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

Prof. Hans Petter Leinaas, University of Oslo, Norway. Collaboration on soil diversity (Chown)

Dr. John Measey, South African National Biodiversity Institute. Collaboration on responses of ectothermic vertebrate communities in the face of global climate change (Clusella-Trullas)

Prof. Jane Molofsky, University of Vermont. Collaboration on ecosystem impacts of *Acacia* invasion: a trait based modeling approach (Richardson)

Dr. Leo Nagelkerke, Wageningen University, Aquaculture and Fisheries Group. Collaboration on alien fish impacts in the Eastern Cape (Weyl)

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

Prof. Petr Pyšek, and Institute of Botany, Academy of Sciences of the Czech Republic. Collaboration on determinants of distribution and spread of alien plants in Kruger National Park (Foxcroft, Richardson)

Prof. Bill Roebuck, Dartmouth College, USA. Collaboration on dung beetle research conducted in Tembe Elephant Park (van Rensburg)

Prof. Daniel Rubinoff, University of Hawaii at Manoa, Department of Plant and Environmental Protection Sciences. Collaboration on phylogeography of North American sphinx moths (Le Roux)

Dr. Zoltán Sallai, Hungarian National Parks; Dr. István Lehoczky, HAKI; Dr. József Lanszki, University of Kaposvár. Collaboration on developing conservation monitoring of otters in Europe and South Africa (Somers)

Dr. Frank Schurr, Plant Ecology and Nature Conservation, University of Potsdam, Potsdam, Germany. Collaboration on fragmentation effects in Fynbos Proteaceae (Esler)

Dr. Cheryl Swift, Department of Biology, Whittier College, Whittier, CA 90608 USA. Collaboration on water relations in riparian trees (Esler)

Dr. John S. Terblanche, Stellenbosch University, Collaboration on ectotherm responses to climate change (Chown)

Dr. Krystal Tolley, South African National Biodiversity Institute. Collaboration on responses of ectothermic vertebrate communities in the face of global climate change (Clusella-Trullas)

Dr. Bieke Vanhooydonck, Dept. of Biology, University of Antwerp. Collaboration on responses of ectothermic vertebrate communities in the face of global climate change (Clusella-Trullas).

4.2.5 Academic visits by core team members to other institutions

Australian Antarctic Division, Hobart, Australia. Collaboration on climate change impacts on sub-Antarctic islands with Dr. Dana Bergström (McGeoch)

Australian Antarctic Division, Hobart, Tasmania. Collaboration on Antarctic biodiversity with Dr. Dana M. Bergstrom (Chown)

Australian Antarctic Division, Hobart, Tasmania. Collaboration on Antarctic spatial planning with Dr. Aleks Terauds (Chown)

Australian Antarctic Division/University of Queensland. Collaboration on Antarctic biosecurity with Dr. Justine D. Shaw (Chown)

Biodiversity Research Group, Dept. of Evolution, Systematics & Ecology, The Hebrew University of Jerusalem. Collaboration on alien invasive impacts on ecological transition areas with Dr. Salit Kark (van Rensburg)

Department of Anatomy and Neurobiology, University of Zurich, Switzerland. Collaboration on small mammal biology with Dr. Irmgard Amrein, (Chimimba)

Department of Ecology, Charles University, Prague, Czech Republic. Collaboration on the determinants of distribution and spread of alien plants in Kruger National Park with Prof. Vojtěch Jarošík (Foxcroft, Richardson)

Department of Human Evolutionary Biology, Harvard University, USA. Collaboration on co-evolution in the Cape: people, plants, animals and extinct ecosystems under the sea' with Prof. Richard Wrangham (Esler)

Institute of Botany, Academy of Sciences of the Czech Republic. Collaboration on the determinants of distribution and spread of alien plants in Kruger National Park with Prof. Petr Pyšek (Foxcroft, Richardson)

Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, USA. Collaboration on co-evolution in the Cape: people, plants, animals and extinct ecosystems under the sea' with Curtis Marean (Esler)

L'Institut de recherche pour le développement, Montpellier, France. Invited guest lecture. Collaboration on Plant Invasion Genetics with Dr. Adeline Barnaud (Le Roux)

National Parks of Hungary, University of Kaposvár and Research Institute for Fisheries, Aquaculture and Irrigation (HAKI). Collaboration on developing conservation monitoring of otters in Europe and South Africa with Mr. Zoltán Sallai, Hungarian National Parks, Dr. István Lehoczky, HAKI and Dr. József Lanszki, University of Kaposvár (Somers)

Paris Museum of Natural History, Paris, France. Collaboration on springtail biodiversity in the Cape Floristic Region with Dr. Louis Deharveng and Dr. Anne Bedos (van Vuuren)

Research School of Arid Environment and Climate Change, Lanzhou University, China. Collaboration on Ecological footprint and bio-capacity patterns of Jinghe River Watershed with Dr. Dongxia Yue (Hui)

Victoria University of Wellington. Collaboration on Antarctic environmental change with Prof. Peter J. Barrett (Chown)

Zoology Department (Ecology/Parasitology), Karlsruher Institut für Technologie, Germany. Collaboration on parasites of South African eel populations with Prof. Horst Taraschewski (Weyl).

4.2.6 Travel awards to Core Team Members

Exploring gender and race: why do social scientists leave academia? Acted as discussant (by invitation) at a University of Johannesburg Sociology, Anthropology & Development Studies Seminar (Prozesky)

HERS-SA Academy, University of Cape Town's Graduate School of Business (Prozesky)

International Association of Landscape Ecology IALE Young Scientist Travel Award (Hui)

NRF Knowledge Interchange and Collaboration grant (Le Roux)

Reserve Managers Workshop, Bodega Bay, USA, March 2011 (Esler)

Review of innovation measurement in South Africa, by invitation of the Department of Science Technology, jointly with the Human Sciences Research Council's Centre for Science, Technology and Innovation Indicators and the National Advisory Council on Innovation (Prozesky)

South Africa-Netherlands Research Programme on Alternatives in Development (SANPAD) Research Capacity Initiative (RCI) Supervisor's Workshop (Prozesky)

4.2.7 Research collaborations

Adoption, use, and perception of Australian acacias around the world. Collaborator: Dr C. Kull, School of Geography and Environmental Science, Monash University, Melbourne, 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. Collaborator: Consortium with Dr. Ad H.L. Huiskes, NIOO, Netherlands and Dr. Dana M. Bergstrom, Australian Antarctic Division, Hobart, Tasmania, Australia (Chown)

Antarctic biodiversity in a spatial context. Collaborators: Drs. Dana M. Bergstrom, Aleks Terauds and Justine D. Shaw, Australian Antarctic Division, Hobart, Tasmania, Australia (Chown)

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

Biodiversity and human evolution. Collaborator: Prof. Curtis Marean, Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, USA and Prof. Richard Cowling, Department of Botany, Nelson Mandela Metropolitan University (Esler)

Biology and ecology of mosquito fish in the Wilderness Lakes system. Dr. Werner Ekau, Leibniz Center for Tropical Marine Ecology, University of Bremen, Germany (Weyl)

Building a social science platform for Antarctic research. Collaborators: Mr. John Cooper (C·I·B Research Associate) and Prof. Sandra Swart, Department of History, Stellenbosch University (Prozesky, Chown)

Carnivore Reintroduction Biology and effects on biodiversity. Collaborators: Micaela Szykman, Humboldt State University, Dave Wildt and Steve Monfort, Smithsonian

Chromolaena odorata and biodiversity in Hluhluwe-iMfolozi Park. Collaborator: Dr. Kate Parr, Research fellow in African ecology, Centre for the Environment, Oxford University (Somers)

Conservation monitoring of otters in Europe and South Africa: Zoltán Sallai, Hungarian National Parks, Dr. István Lehoczky, HAKI, Dr. József Lanszki, University of Kaposvár, Prof. Antoinette Kotze and Thabang Madisha, National Zoological Gardens and Kelly Marnewick, Endandered Wildlife Trust (Somers)

Determinants of distribution patterns and spread of plant invasions in protected areas. Collabroators: Prof. Vojtěch Jarošík, Department of Ecology, Charles University, Czech Republic, and Prof. Petr Pyšek, Institute of Botany, Academy of Sciences of the Czech Republic (Foxcroft, Richardson)

Dispersal of the European starling. Collaborators: Dr. Karl L. Evans, Department of Animal and Plant Sciences, University of Sheffield and Dr. Robert A. Robinson, British Trust for Ornithology (Hui)

Drought response in Fynbos. Collaborator: Dr. Anna Jacobsen, Department of Biology, California State University (Esler)

Dynamic niche modelling. Collaborators: Dr. Lluis Brotons and Dr. Miquel De Cáceres, Biodiversity & Landscape Ecology Lab, Centre Tecnològic Forestal de Catalunya, Dr. Miguel B. Araújo, CSIC, Prof. Marie-Josée Fortin, Department of Ecology & Evolutionary Biology, University of Toronto, Dr. Wilfried Thuiller, CNRS and Dr. Andrew Fall, Resource and Environmental Management, Simon Fraser University (Hui)

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

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

Genetic monitoring of endangered species in KwaZulu-Natal. Collaborator: Dr. Peter Goodman, formerly from Ezemvelo KZN Wildlife, now independent (van Vuuren)

Genetic patterns associated with climate change in Madagascar. Collaborator: Dr. Steven M. Goodman, Field Museum of Natural History, Chicago, USA and Association Vahatra, Antananarivo, Madagascar (van Vuuren)

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

Genetic status of the African wild cat (*Felis silvestris lybica*) and the potential risk of hybridisation with feral domestic cats (*Felis catus*). Dr. Marna Herbst, South African National Parks (Foxcroft, Le Roux).

Genetics of Australian acacias. Collaborator: Dr J.L. Miller, CSIRO Plant Industry, Australia (Le Roux, Richardson)

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

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

Global Environmental Change: Invasive alien species in South African National Parks. Collaborators: Dr. Dian Spear and Dr. Nicola van Wilgen, Cape Research Centre, SANParks, and DST-NRF Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University (Foxcroft, McGeoch)

Human impacts on Antarctic biodiversity: a trans-disciplinary approach. Collaborators: Prof. Sandra Swart; Prof. Melodie McGeoch, Cape Research Centre, SANParks, Dr. Jennifer Lee, Government of South Georgia and South Sandwich Islands, Mr. John Cooper and Prof. Rosemary Dorrington, Rhodes University (Chown, Prozesky)

Impacts of alien fishes in South African aquatic ecosystems. Collaborator: Dr. Leo Nagelkerke, Wageningen University, Aquaculture and Fisheries Group, Prof. Nico Smit, Department of Zoology, University of the North West, South Africa, Prof. Jen Snowball, Department of Economics, Rhodes University and Prof. Peter Britz, Department of Ichthyology and Fisheries Science, Rhodes University (Weyl)

Impacts of alien invasive plants in ecological transition zones. Collaborator: Dr. Salit Kark, Biodiversity Research Group, Dept. of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem (van Rensburg)

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 and Dr. Dean Impson, CapeNature (Griffiths)

Institution, Elisa Cameron, University of Tasmania, Harriet Davies, Endangered Wildlife Trust, Rob Slotow, University of KwaZulu-Natal and Matt Hayward, Australian Wildlife Conservancy (Somers)

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

Land owner attitudes to invasive plants. Collaborators: Dr. Guy Preston, Natural Resources Management Programme, Dept. Environmental Affairs and Ms. Lauren Urgenson, Washington State University, USA (Esler, Prozesky)

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

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

Macroecology and macrophysiology for a changing world. Collaborator: Prof. Kevin J. Gaston, University of Exeter (Chown)

Macrophysiology of marine invertebrates. Collaborators: Dr. Lloyd Peck, British Antarctic Survey, Cambridge, UK (Chown, Clusella-Trullas)

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

Multi-stakeholder assessment of incentives and barriers to invasive plant management in the Western Cape. Collaborator: Dr. Lauren Urgenson, Washington State University, USA (Prozesky, Esler)

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)

Parasites of South African eels. Prof. Horst Taraschewski, Zoology Department (Ecology/Parasitology), Karlsruher Institut für Technologie, Germany (Weyl)

Parasites of the alien crab *Carcinus maenas*. Collaborator: Claudia Zetlmeisl, Universität Karlsruhe, Germany (Griffiths)

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

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

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

Plasticity of active metabolism and speed of locomotion in insects. Collaborators: Dr. John S. Terblanche, Department of Entomology and Conservation (Clusella-Trullas).

Post-fire regeneration in Fynbos. Collaborator: Dr. Brandon Pratt, Department of Biology, California State University, USA (Esler)

Predicting invasiveness of Australian acacias. Collaborator: Dr P. Castro-Diez, Departamento de Ecología, Universidad de Alcalá, Madrid, Spain (Richardson)

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

Rattus systematics, biogeography and associated diseases. Collaborators: Dr. Ara Monadjem, Department of Biological Sciences, University of Swaziland (Chimimba)

Restoration and monitoring of invasive species. Collaborator: Dr. Belinda Reyers, CSIR, Natural Resources and Environment (Esler)

Restoration of natural capital. Collaborators: Prof. James Blignaut, ASSET, Jabenzi, Beatus and Department of Economics, University of Pretoria, Dr. David Le Maitre,

CSIR, Natural Resources and Environment and Prof. Sue Milton, RENU KAROO (Esler)

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

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

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

South African and introduced megadriles (earthworms). Collaborators: Dr. Sandi Willows-Munro, University of KwaZulu-Natal, Dr. Danuta Plisko, KwaZulu-Natal Museum (Wilson)

Spatial appraisal of ecological footprint. Collaborator: Dr. Dongxia Yue, Research School of Arid Environment and Climate Change, Lanzhou University (Hui)

Springtail diversity in the Western Cape. Collaborators: Prof. Louis Deharveng and Dr. Anne Bedos, National Museum of Natural History, Paris (Chown, van Vuuren).

The role of species traits and genome size in invasiveness. Collaborator: Prof. M. Leishman, Department of Biological Sciences, Macquarie University, NSW, Australia (Richardson)

Trait-based evolutionary changes in Australian acacias. Collaborator: Dr. Michelle Leishman, Department of Biological Sciences, Macquarie University, North Ryde, Australia. (Le Roux)

Water relations in riparian vegetation. Dr. Cheryl Swift, Department of Biology, Whittier College, 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

5.2.1 National panels and committees

AfriOceans Conservation Alliance: Board member (Griffiths)

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

CAPE Invasive Alien Animals Working Group: member (Davies, McGeoch)

Centre of Excellence at the Percy FitzPatrick Institute, University of Cape Town: Advisory Board member (Chimimba)

Conservation Task Team of Vhembe Biosphere Reserve: member (Foord)

CSIR Natural Resources and the Environment, Working for Water Research Project Reference Panel: member (Foxcroft)
Fynbos Forum Committee: member (Esler)
Fynbos Node Steering Committee, South African Environmental Observation Network: member (McGeoch)
Green Trust: Board of Trustees member (Chimimba)
Helderberg Nature Reserve: Advisory Board member (Wossler)
HERS Advisory Board: Chair (Esler)
IUCN Wild Dog Advisory Group of South Africa: member (Somers)
National Scholarly Editors Forum (NSEF) of the Academy of Science of South Africa: Organising Committee member (Foxcroft)
Plant Conservation Unit, University of Cape Town: Research Review Panel member (Esler)
Prince Edward Islands Management Committee: member (Chown)
SAEON Fynbos Node Liaison committee: member (Esler)
South African Data Centre for Oceanography (SADCO): Board member (Griffiths)
South African National Committee for the Scientific Committee on Antarctic Research: member (van Vuuren)
South African National Survey of Arachnida (SANSA): Steering Committee member (Chimimba)
Working for Water: National Invasive Alien Plant Survey Project Reference Group member (Wilson)
Zoological Society of Southern Africa [ZSSA homepage: http://www.zssa.co.za/]: Council member (van Rensburg, van Vuuren)

5.2.2 International panels and committees

International Advisory Board Member for the International Union for the Study of Social Insects (IUSSI) 2014, Cairns: member (Wossler)
International Association for Biological Oceanography (IABO) Executive Member and South African National Representative (Griffiths)
IUCN Mediterranean-Type Ecosystem Thematic Group: Member (Esler)
IUCN Species Survival Specialist Group on Conifers: Member (Richardson)
IUCN Species Survival Specialist Group on Invasive Organisms: Member (Foxcroft, Richardson, van Wilgen)
IUCN Species Survival Specialist Group on Southern African Plants: Member (Richardson)
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)
IUCN-SSC Small Carnivore Specialist Group: member (Somers)
MEDECOS Association Executive committee, ISOMED: National Representative (Esler)
Mediterranean Research managers International Cooperative: Member (Esler)
SCAR Antarctic Treaty System Standing Committee: Chief Officer (Chown)
Survey of Social Sciences and Humanities Scholars on Engagement in Global Environmental Change Research, International Human Dimensions Programme on Global Environmental Change (IHDP): Steering Committee member and South African representative (Prozesky).

5.2.3 Editorial and refereeing activities

Editor

INTERNATIONAL JOURNALS
Diversity and Distributions, Editor-in-Chief (Richardson)
Journal of Biogeography, Editor (McGeoch).

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

Associate Editor

INTERNATIONAL JOURNALS
Acta Ichthyologica et Piscatoria (van Vuuren)
Biological Invasions (Hui, Le Roux, Richardson)
Diversity and Distributions (Wilson)
Fire Ecology (van Wilgen)
International Journal of Wildland Fire (van Wilgen)
Journal of Biogeography (van Vuuren)
Mammalian Biology (van Vuuren)
Marine Biology (Griffiths)
Molecular Ecology (van Vuuren)
Neobiota (Foxcroft, Richardson)
PLoS ONE, Academic Editor (Somers)
Zootaxa (van Vuuren).

NATIONAL JOURNALS
African Entomology, Assistant Editor (Wossler)
African Zoology (van Vuuren, Weyl)
South African Journal of Science (van Wilgen).

Editorial Boards

INTERNATIONAL JOURNALS
African Natural History (Griffiths)
Animals (Griffiths)
Antarctic Science (Chown)
Applied Mathematics and Computational Sciences (Hui)
Arthropod-plant interactions, Handling Editor (Johnson)
Austral Ecology (McGeoch)
Biological Reviews of the Cambridge Philosophical Society (Chown)
BMC Ecology (Chown)
Book series *Conservation Biology* (Cambridge University Press) (Richardson)
Book series *Ecology, Biodiversity, and Conservation* (Cambridge University Press) (Richardson)
Environmental Development (Richardson)
Environmental Management (Richardson)
Frontiers in Invertebrate Physiology, Review editor (Clusella-Trullas)
International Journal of Wildland Fire, Editorial Advisory Committee member (van Wilgen)
ISRN Ecology (Esler)
Journal of Thermal Biology (Clusella-Trullas)

Oecologia, Handling Editor (Johnson)
Polar Biology (Chown)
Proceedings of the Royal Society of London B (Chown)
Smithiana (Griffiths)
The Open Zoology Journal (Hui)
TheScientificWorldJOURNAL (Hui).

NATIONAL JOURNALS
African Journal of Aquatic Science (Weyl)
African Zoology (Griffiths)
Koedoe (Griffiths, McGeoch)
Navorsinge van die Nasionale Museum, Bloemfontein, Consulting Editor (Chimimba).

Reviewing
INTERNATIONAL JOURNALS
Acta Theriologica; *African Entomology*; *African Journal of Agriculture*; *African Journal of Ecology*; *American Naturalist*; *Annals of Botany*; *Animal Conservation*; *Annals of Forest Science*; *Antarctic Science*; *Austral Ecology*; *Australian Journal of Botany*; *Behavioral Ecology and Sociobiology*; *Biodiversity and Conservation*; *Biological Conservation*; *Biological Invasions*; *Biology Letters*; *Community Ecology*; *Comprehensive Physiology*; *Conservation Biology*; *Current Biology*; *Diversity and Distributions*; *Ecography*; *Ecological Economics*; *Ecological Modelling*; *Ecology*; *Ecology Letters*; *Environmental Science & Policy*; *European Journal of Forest Research*; *Evolution*; *Fisheries Management and Ecology*; *Forest Ecology and Management*; *Functional Ecology*; *Global Change Biology*; *Global Ecology and Biogeography*; *Insectes Sociaux*; *Integrative and Comparative Biology*; *International Journal of Wildland Fire*; *ISRN Ecology*; *Journal of Applied Ecology*; *Journal of Applied Geography*; *Journal of Biogeography*; *Journal of Ecology*; *Journal of Environmental Management*; *Journal of Experimental Biology*; *Journal of Insect Physiology*; *Journal of Thermal Biology*; *Journal of Zoology*; *Landscape and Urban Planning*; *Landscape Ecology*; *Marine Biology*; *Marine Biology Research*; *Methods in Ecology and Evolution*; *Molecular Ecology*; *Molecular Phylogenetics and Evolution*; *Neobiota*; *Oecologia*; *Oikos*; *Plant Biology*; *Plant Ecology & Diversity*; *PLoS Biology*; *PLoS One*; *Polar Biology*; *Preslia*; *Proceedings of the Royal Society B*; *Proceedings of the National Academy of Sciences USA*; *Psyche*; *Reviews in Fish and Fisheries*; *Science*; *The Southeastern Naturalist*; *Trends in Ecology and Evolution Water Research*.

NATIONAL JOURNALS
African Journal of Aquatic Science; *African Journal of Marine Science*; *African Zoology*; *Koedoe*; *African Entomology*; *South African Journal of Botany*; *South African Journal of Science*; *South African Review of Sociology*; *Water SA*.

Reviews of book proposals for international publishers:
CABI - review of book proposal (Richardson)
Cambridge University Press - review of book proposal (Richardson)
Oxford University Press - review of book proposal (Richardson)
Wiley-Blackwell - review of book proposal (Richardson)

Grant reviews for external bodies

Biotechnology and Biological Sciences Research Council (BBSRC), UK Department of Agriculture, Technology, Research & Development Services
INACH (Chilean Antarctic Institute), Proposal (Chown)
National Science Foundation, USA, Proposal (Chown)
Netherlands Organisation for Scientific Research (Richardson).
The Claude Leon Foundation
Water Research Commission

Appointment reviews and committees

Faculty of Natural & Agricultural Sciences, University of Pretoria. Appointments and Promotions Committee: Permanent Member (Chimimba)
Fynbos Forum Scholarship Committee. Chair (McGeoch)
Rutgers University, New Jersey, candidate promotion (Chown)
Syracuse University, USA: associate professorial appointment (Richardson)
University of Melbourne, Australia: professorial appointment (Richardson)
University of Pretoria: associate professorial promotion (Richardson)
University of Tennessee, USA: professorial appointment (Richardson)
University of Toronto, Mississauga, Canada: professorial promotion (Richardson)

Conferences/workshops organized

7th Scientific Committee on Antarctic Research History Workshop, Stellenbosch Institute for Advanced Study, Stellenbosch University, 26-29 July 2011.

Consulting and other services rendered

GEOBON. 2011. Adequacy of Biodiversity Observation Systems to support the CBD 2020 Targets. Report prepared by the Group on Earth Observation Biodiversity Observation Network (GEO BON), the IUCN and the World 10 Conservation Monitoring Centre, for the Convention on Biological Diversity, Pretoria, South Africa, 102 pp. (contributor and co-author)

National Environmental Management: Biodiversity Act. The Centre has continued to consider the regulations for Chapter 5 of this Act, offering advice to the National Department of Environmental Affairs and the South African National Biodiversity Institute as requested and typically at no charge.

6 Gender impact of research

The Centre staff and student complements reflect an on-going promotion of the interests of women in science. The majority of both the staff and student complement is women. Much emphasis is also placed on ensuring that women have ample access to opportunities to further their careers. Part of the research of the Centre continue to focus on the social impacts of the Working for Water programme, of which women form a key element.

7 Human resources

7.1 Core team members

Name	Citizenship	Institution	Race	Gender	Time spent working in CoE (%)
Prof. Steven Chown	South Africa	SU	W	M	100
Prof. David Richardson	South Africa	SU	W	M	100
Ms. Sarah Davies	South Africa	SU	W	F	100
Prof. Chris Chimimba	South Africa	UP	B	M	15
Dr. Susana Clusella-Trullas	Spain	SU	W	F	100
Prof. Karen Esler	South Africa	SU	W	F	40
Dr. Stefan Foord	South Africa	UniVen	W	M	60
Dr. Llewellyn Foxcroft	South Africa	SANParks	W	M	5
Prof. Charles Griffiths	South Africa	UCT	W	M	20
Dr. Cang Hui	China	SU	B	M	100
Prof. Steven Johnson	South Africa	UKZN	W	M	20
Dr. Jaco le Roux	South Africa	SU	W	M	100
Prof. Melodie McGeoch	South Africa	SANParks	W	F	15
Dr. Augustine Niba	Cameroon	WSU	B	M	15
Dr. Heidi Prozesky	South Africa	SU	W	F	5
Dr. Victor Rambau	South Africa	SU	B	M	5
Prof. Michael Samways	South Africa	SU	W	M	25
Prof. Michael Somers	South Africa	UP	W	M	5
Prof. Berndt van Rensburg	South Africa	UP	W	M	55
Prof. Bettine van Vuuren	South Africa	SU & UJ	W	F	35
Dr. Brian van Wilgen	South Africa	CSIR	W	M	5
Dr. Olaf Weyl	South Africa	SAIAB	W	M	20
Dr. John Wilson	South Africa	SANBI	W	M	100
Prof. Theresa Wossler	South Africa	SU	W	F	30

7.2 Post-doctoral associates

Name	Citizenship	Institution	Race	Gender	Time spent working in CoE (%)
Dr. Cécile Berthouly-Salazar	France	SU	W	F	100
Dr. Brigitte Braschler	UK	SU	W	F	100
Dr. Mirijam Gaertner	Germany	SU	W	F	100
Dr. Sjirk Geerts	SA	SU	W	M	100
Dr. Rainer Krug	Germany	SU	W	M	100
Dr. Jennifer Lee	UK	SU	W	F	100
Dr. Denise Mager	Austria	SU	W	F	100
Dr. Dian Spear	UK	SU	W	F	100
Dr. Vernon Visser	SA	SU	W	M	100
Dr. Christopher Weldon	Australia	SU	W	M	100
Dr. Darragh Woodford	SA	SU	W	M	100
Dr. Feng Zhang	China	SU	B	M	100

7.3 Students supported

Name	Citizenship	Institution	Race	Gender	Status
Honours/4 year B. degree:					
Mr. Pieter Botha	SA	SU	W	M	Graduated
Mr. Evans Chauke	SA	SU	B	M	Graduated
Ms. Marinel Janse van Rensburg	SA	SU	W	F	Graduated
Ms. Evans Mauda	SA	UniVen	B	M	Pending
Mr. Sifiso Mjobo	SA	WSU	B	M	Pending
Ms. Thembelihle Mlokoti	SA	WSU	B	F	Pending
Mr. Rifilwe Modiba	SA	UniVen	B	M	Pending
Mr. Vuledzani Mukwevho	SA	UniVen	B	M	Pending
Mr. Duncan Nengwenani	SA	UniVen	B	M	Pending
Ms. Khantse Serobe	SA	UFS	B	F	Pending
Ms. Likho Sikutshwa	SA	WSU	B	F	Pending
Masters (M.A. and M.Sc.):					
Ms. Jessica Allen	SA	SU	W	F	Continuing
Mr. Antoine Bahizi	Rwanda	SU	B	M	Continuing
Ms. Helene Basson	SA	SU	W	F	Continuing
Ms. Samantha de la Fontaine	SA	SU	B	F	Continuing
Ms. Katelyn Faulkner	SA	SU	W	F	Completed
Mr. Muhammed Gardee	SA	SU	B	M	Continuing
Ms. Michelle Gibson	USA	SU	W	F	Completed
Ms. Analicia Govender	SA	SU	B	F	Resigned
Ms. Wilna Jansen	SA	UP	W	F	Pending
Ms. Rolanda Julius	SA	UP	B	F	Pending
Ms. Haylee Kaplan	SA	SU	W	F	Completed
Ms. Elizabeth Kleynhans	SA	SU	W	F	Completed
Ms. Vanessa Matukana	SA	UniVen	B	F	Continuing
Mr. Dickson Mazibuko	Malawi	SU	B	M	Pending
Ms. Nokuthula Mbanyana	SA	SU	B	F	Continuing
Mr. Matthew Miles	SA	UKZN	W	M	Pending
Mr. Jason Mingo	SA	SU	W	M	Resigned
Mr. Mohlamatsane Mokhatla	SA	UP	B	M	Pending
Ms. Desika Moodley	SA	SU	B	F	Continuing
Mr. Norman Nelufule	SA	SU	B	M	Resigned
Ms. Savannah Nuwagaba	Uganda	SU	B	F	Continuing
Ms. Alexis Olds	SA	Rhodes	W	F	Completed
Mr. Dylan Prentice	SA	UP	W	M	Submitted
Ms. Jean Purdon	SA	UP	W	F	Completed
Ms. Madeleine Ramantswana	SA	SU	B	F	Submitted
Mr. Andrew Rogers	USA	SU	W	M	Completed
Ms. Azwinndini Sebola	SA	UniVen	B	F	Pending
Ms. Daisy Thononda	SA	UniVen	B	F	Continuing
Mr. Allen Tshautshau	SA	SU	B	M	Continuing
Ms. Francis van der Merwe	SA	SU	W	F	Completed
Ms. Waafeka Vardien	SA	SU	B	F	Completed
Ms. Carlien Vorster	SA	SU	W	F	Completed
M.Sc.-Ph.D. upgrade:					
Ms. Genevieve Thompson	SA	SU	W	F	Continuing
Mr. James Rodger	SA	UKZN	W	M	Completed

Name	Citizenship	Institution	Race	Gender	Status
Ph.D.:					
Mr. Ryan Blanchard	SA	SU	B	M	Continuing
Ms. Marguerite Blignaut	SA	SU	W	F	Continuing
Mr. Emile Bredenhand	SA	SU	W	M	Pending
Mr. Bernard Coetzee	SA	SU	W	M	Pending
Mr. Andrew Davies	SA	SU	W	M	Continuing
Ms. Sarah Davies	SA	SU	W	F	Continuing
Ms. René Gaigher	SA	SU	W	F	Pending
Ms. Tanya Haupt	SA	SU	B	F	Continuing
Ms. Sanet Hugo	SA	UP	W	F	Pending
Ms. Charlene Janion-Scheepers	SA	SU	W	F	Continuing
Ms. Candice Lyons	SA	SU	W	F	Continuing
Mr. Sean Marr	SA	UCT	W	M	Pending
Mr. Matthew McConnachie	SA	Rhodes	W	M	Pending
Mr. Gregory McClelland	Canada	SU	W	M	Pending
Ms. Mandisa Mgobozi	SA	UKZN	B	F	Continuing
Mr. Phemelo Mogodi	SA	UNW	B	M	Continuing
Ms. Natasha Mothapo	SA	SU	B	F	Continuing
Mr. James Mugabe	Zimbabwe	SU	B	M	Dismissed
Mr. Caswell Munyai	SA	UniVen	B	M	Continuing
Ms. Joyce Ndlovu	Zimbabwe	SU	B	F	Continuing
Ms. Unjinee Poonen	SA	WITS	B	F	Pending
Mr. Andriamihaja Ramanantoanina	Madagascar	SU	B	F	Continuing
Mr. Sheunesu Ruwanza	Zimbabwe	SU	B	M	Continuing
Mr. Jeremy Shelton	SA	UCT	W	M	Continuing
Mr. Farai Tererai	Zimbabwe	SU	B	M	Continuing
Ms. Ann Treasure	SA	SU	W	F	Completed
Ms. Lize-Marie van der Watt	SA	SU	W	F	Completed
Mr. Tsungai Zengeya	Zimbabwe	UP	B	M	Pending
Mr. Matthew Zylstra	Australia	SU	W	M	Pending

7.4 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
Mr. Ricardo Davids *	SU	Social Science Database Assistant	B	M
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. Keafon Jumbam	SU	Technical Officer: Iimbovane Outreach Project	B	F
Ms. Thembile Khoza	SU	Technical Officer: Long Term Projects	B	F
Ms. Suzaan Kritzinger-Klopper	SU	Senior Technical Officer	W	F
Ms. Tlou Manyelo	SU	Technical Officer: Long Term Projects	B	F
Ms. Christy Momberg	SU	PA to D.M. Richardson	W	F
Ms. Rhoda Moses	SU	Administrative Assistant	B	F
Ms. Irene Muelelwa	SU	Assistant Technical Officer: Iimbovane	B	F
Ms. Erika Nortje	SU	Principal Technical Officer: Lab Management	W	F
Ms. Charlene Janion-	SU	Technical Officer: Norway-Sweden Projects	W	F

Name	Inst.	Position	Race	Gender
Scheepers				
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

*Resigned: November 2011

7.5 Resources in the market place

Graduate name	Level	Supervisor	Position/Organisation
Mr. Emile Bredenhand	Ph.D.	Prof. Samways	Lecturer, University of the Free State
Ms. Haylee Kaplan	M.Sc.	Dr. Wilson	Contract with EDRR, SANBI, Cape Town
Dr. Jennifer Lee	Ph.D.	Prof. Chown	Environmental Officer, Government of South Georgia and South Sandwich Islands
Dr. Rainer Krug	Post-doc	Prof. Richardson	C·I·B Research Associate
Ms. Monique Masang	M.Sc.	Prof. Griffiths	Extended Curriculum Officer, University of the Western Cape
Mr. Sean Marr	Ph.D.	Prof. Griffiths	Lecturer, Department of Zoology, University of Cape Town
Mr. Matthew McConnachie	Ph.D.	Prof. Cowling	Assistant, Limpopo Transboundary Programme, WfW
Ms. Unjinee Poonan	Ph.D.	Prof. Cock	Policy Co-ordinator, Action Aid International, South Africa's Campaign
Dr. Marc Rius	Post-doc	Prof. Griffiths	Department of Ecology, University of California
Dr. James Rodger	Ph.D.	Prof. Johnson	Post-Doctoral Associate, Department of Botany & Zoology, Stellenbosch University
Dr. Anne Treasure	Ph.D.	Prof. Chown	Post-Doctoral Associate, Department of Oceanography, University of Cape Town
Ms. Charmaine Uys	M.Sc.	Prof. Griffiths	Manager, Grasslands Programme, BirdLife South Africa
Ms. Julia Francis van der Merwe	M.Sc.	Prof. Wossler	Internship at City of Cape Town
Ms. Carlien Vorster	M.Sc.	Prof. McGeoch	Research Assistant, Department of Conservation Ecology, Stellenbosch University
Dr. Chris Weldon	Ph.D.	Prof. Chown	Lecturer, Department of Zoology & Entomology, University of Pretoria

8 Outputs

8.1 Books

De Villiers, M.S., Chown, S.L. and Cooper, J. (2011). *Prince Edward Islands Conservation Handbook – Keeping Your Footprint at the Islands Small*. SUN Press, Stellenbosch. 80 pp, ISBN: 978-1-920338-54-1.

Picker, M. and Griffiths, C.L. (2011). *Alien & Invasive Animals: A South African Perspective*. Struik Nature, Cape Town. 248 pp, ISBN: 9781770078239.

Richardson, D.M. (Ed.) (2011). *Fifty Years of Invasion Ecology. The Legacy of Charles Elton*. Wiley-Blackwell, Oxford. 456 pp, ISBN: 978-1-4443-3586-6.

8.2 Book chapters

Chown, S.L. and Klok, C.J. (2011). The ecological implications of physiological diversity in dung beetles. In: *Ecology and Evolution of Dung Beetles.* Simmons, L.W. and Ridsdill-Smith, T.J. (eds.). Wiley-Blackwell, Oxford. pp. 200 - 219.

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8.4 Published conference proceedings

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8.5 Published conference abstracts

Nthsotsho, P., Reyers, B. and Esler, K.J. (2011). Towards evidence-based restoration: The essential components. In: *Abstract. 4th World Conference on Ecological Restoration.* Merida, Mexico. p. 152.

Richardson, D.M., Hui, C., le Roux, J.J. and Wilson, J.R.U. (2011). Australian acacias take on the world: Lessons for management from a global translocation experiment. In: *Abstract. The 96th ESA Annual Meeting.* Austin, Texas, USA.

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8.6 Products / Artifacts / Patents

None

8.7 Conferences / meetings attended

8.7.1 Plenary/Keynote Presentations

International

Chown, S.L. The future of the Sub-Antarctic region: its global significance and value. *Closing plenary address. Third International Forum on the Sub-Antarctic, Hobart, Australia, August 2011.*

Chown, S.L. The ongoing consequences of climate change: lessons from and for ectotherms. *Plenary address. Third Combined Australian and New Zealand Entomological Societies Conference, Lincoln, New Zealand, August 2011.*

Esler, K.J. Key Management Issues: Cape Floristic Region, South Africa. *Invited plenary address at Mediterranean Manager Training Workshop. Bodega Bay, California, United States of America, March 2011.*

Richardson, D.M. (Plant) invasion science - the roads travelled and the roads ahead. *Opening plenary address at 11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Hungary, August 2011.*

National

Chown, S.L. Arthropod assemblages and environmental change: lessons for the long term. *Opening plenary address at the XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Hui, C. The dispersal strategy of common starlings in native and non-native areas. *Zoological Society of Southern Africa, Stellenbosch, July 2011.*

McGeoch, M.A. The changing face of protected areas. Opening address at the South African Wildlife Management Association Symposium, Hartenbos, September 2011.

8.7.2 Oral presentations

International

Beckett, S.E. and Prozesky, H.E. Hegemonic definitions from the 'North': environmental concern as a western construct and its applicability to the South African and Antarctic context. *SCAR (Scientific Committee for Antarctic Research) Social Science Action Group Interdisciplinary Workshop, Exploring linkages between environmental management and value systems – the case of Antarctica*, *Christchurch, New Zealand, December 2011.*

Blignaut, M., Esler, K.J., Ellis, A. and Le Roux, J.J. Comparative epi-genetic and genetic population structure of the highly invasive bunch grass, *Pennisetum setaceum* along an environmental gradient in South Africa. *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Cooper, J., Prozesky, H., Scott, D. and Van Der Watt, L-M. The SANAP Antarctic Legacy Project at the University of Stellenbosch: An historical overview of South Africa's involvement in the Antarctic and Sub-Antarctic. *7th International SCAR Action Group on History of Antarctic Research workshop, Stellenbosch, South Africa, July 2011.*

Davies, A.B., Eggleton, P., Van Rensburg, B.J. and Parr, C.L. Litter decomposition in African savannas: comparative roles of climate, litter quality and termites. *48th Annual meeting of the Association of Tropical Biology and Conservation, Arusha, Tanzania, June 2011.*

Esler, K.J. Restoring South African mediterranean-type ecosystems following alien plant invasion. *Invited paper: MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Esler, K.J., Jacobs, S., Swift, C., Pettit, N., Reinecke, K., Aguilar, F. and Buisson, E. Riparian Vegetation Structure and Function in Mediterranean Type Ecosystems: A review. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Forsyth, G.G., Kruger, F.J., Le Maitre, D.C. and Van Wilgen, B.W. Classification of South Africa in terms of wildfire risk. *5th International Wildland Fire Conference, Sun City, South Africa, May 2011.*

Foxcroft, L.C., Spear, D., McGeoch, M.A. and Van Wilgen, N.J. Nature rearranged: assessing invasive alien species as a driver of environmental change in South African National Parks. *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Hui, C. Defining optimal sampling effort for large-scale monitoring of invasive alien plants: a Bayesian method for estimating abundance and distribution. *8th International Association of Landscape Ecology (IALE) World Congress, Beijing, China, August 2011.*

Jacobs, S., Esler, K.J., Naude, M., Kambaj, O., Slabbert, E., Cowan, D., Jacobs, K., Mantlana, B. and Rozanov, A. Invasive trees, microbes and nutrient cycling in fynbos riparian ecotones. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Jacobs, S., Esler, K.J., Naude, M., Slabbert, E., Cowan, D., Jacobs, K., Mantlana, B., and Rozanov, A. An overview of the impacts of disturbances on structure and functioning of fynbos riparian zones. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Jansen van Vuuren, B. Genetic patterns in the Antarctic and Sub-Antarctic. *Antarctic Forum Meeting, Tasmania, August 2011.*

Kalwij, J.M., Robertson, M.P. and Van Rensburg, B.J. Upward shifts in altitudinal limits of exotic plants in a montane grassland. *54th Symposium of the International Association for Vegetation Science, Lyon, France, June 2011.*

Krug, R. Spatial modelling with the R-GRASS Interface. *The R User Conference. University of Warwick, Coventry, United Kingdom, August 2011.*

Le Roux, J.J., Thompson, G.T., Wilson, J.R.U., Bellstedt, D.U. and Richardson, D.M. What can intra-specific gene variation tell us about *Acacia saligna* invasions in South Africa – Implication for species distribution modelling. *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Marais, K.E., Esler, K.J., Jacobs, S.M, Pratt, R.B. and Jacobsen, A.L. Post-fire regeneration of mountain fynbos: A comparison of two sprouting life history types. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

McGeoch, M.A. From policy to practice via the science of invasion biology. *Programme of the 25th International Congress of the Society for Conservation Biology, Auckland, New Zealand, December 2011.*

Munyai, T.C. and Foord, S.H. Ants on mountains: space and environment along an altitudinal transect in a centre of endemism: implications for long term monitoring. *Spatial Ecology and Conservation, University of Birmingham, United Kingdom, September 2011.*

Naude, M., Jacobs, S. and Esler, K.J. Fynbos riparian biogeochemistry and invasive alien Acacias. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Nthsotsho, P., Reyers, B. and Esler, K.J. Towards evidence-based restoration: The essential components. *SER 2011, 4th World Conference on Ecological Restoration, Merida, Mexico, August 2011.*

Ramanantoanina, A., Ouhinou, A. and Hui, C. A density-dependent diffusion model for a two-phase invasion. *European Conference on Mathematical and Theoretical Biology (ECMTB), Krakow, Poland. July 2011.*

Richardson, D.M. and Gaertner, M. Insights on novel ecosystems from South African fynbos. *Conference and workshop on 'Novel Ecosystems: When and how do we intervene in the new world ecological order?' Poets Cove, British Columbia, Canada, May 2011.*

Richardson, D.M. Factors driving plant invasions. *European Science Foundation workshop on 'Risk assessment analysis: Methods and applications for evaluating biological invasions', Girona, Spain, April 2011.*

Richardson, D.M. Impacts of invasive species. ***C****onference on 'Ecological novelty', Ascona, Switzerland, September 2011.*

Richardson, D.M., Hui, C., Le Roux, J.J. and Wilson, J.R.U. Australian acacias take on the world: Lessons for management from a global translocation experiment. *Ecological Society of America Annual Conference, Austin, Texas, United States of America, August 2011.*

Spear, D., McGeoch, M.A., van Wilgen, N.J. & Foxcroft, L.F. Potential impacts and pathways of introduction of alien animal species in protected areas. *2nd World Conference on Biological Invasions and Ecosystem Functioning (BIOLIEF), Argentina, November 2011.*

Steenkamp, K., Forsyth, G.G. Frost, P., Archibald, S., McFerren, G. and Van Wilgen, B.W. Characterising severe fire events in South Africa, *5th International Wildland Fire Conference, Sun City, South Africa, May 2011.*

Zylstra, M., Knight, A.T., Esler, K.J. and Le Grange, L. Out of this world view: when aliens invade our experience of nature. *4th World Conference on Ecological Restoration, Merida, Mexico, August 2011.*

National

Allen, J.L., Chown, S.L., Clusella-Trullas, S. and Marais, E. Thermal Physiology of *Cyrtobagous salviniae*: broader implications. *XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Braschler, B. Ants: ecosystem engineers at the interface of soil and surface. *XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Chown, S.L. Beetle assemblages and soil ecology. *XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Clusella-Trullas, S. and Terblance, J.S. Flight-induced endothermy in a small dung beetle. *Zoological Society of Southern Africa General Meeting, Stellenbosch, July 2011.*

Coetzee, B.W.T. and Chown, S.L. Species assembly patterns and protected area effectiveness in times of change. *Joint conference of the Zoological Society of Southern Africa and the Parasitological Society of Southern Africa, Stellenbosch, July 2011.*

Ellender, B.R., Becker, A., Weyl, O.L.F. and Swartz, E.R. The feasibility of underwater video analysis as a non-destructive alternative to three pass electrofishing for sampling headwater stream fishes. *South African Society of Aquatic Science. Ithala Game Reserve, KwaZulu-Natal, June 2011.*

Gaboriaud, C., Berthouly-Salazar, C., Hui, C., Le Roux, J.J., Van Rensburg, B.J. and Jansen van Vuuren, B. Patterns of genetic variation in the Common starling, *Sturnus vulgaris*, in South Africa, *Zoological Society of Southern Africa (ZSSA), Stellenbosch, July 2011.*

Gaboriaud, C., Berthouly-Salazar, C., Van Rensburg, B.J., Hui, C., Le Roux, J. and Jansen van Vuuren, B. Population genetic structure of the invasive common starling

(*Sturnus vulgaris*). *Zoological Society of Southern Africa (ZSSA), Stellenbosch, July 2011.*

Geerts, S. and Wilson, J.R.U. Reproductive ecology and demography of incipient plant invaders. *39th Annual workshop on biological and integrated control of weeds, Bloemfontein, July 2011.*

Haupt, T., Sinclair, B.J. and Chown, S.L. Thermal sensitivity of *Pringleophaga marioni* caterpillars on sub-Antarctic Marion Island: is hotter better? *XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Janion, C. Collembola diversity in the Fynbos: a first assessment. *XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Kaplan, H., Wilson, J.R.U., Van Niekerk, A., Le Roux, J.J. and Richardson, D.M. Predicting spread pathways of emerging invader *Acacia stricta* for potential eradication. *39th Annual workshop on biological and integrated control of weeds, Bloemfontein, July 2011.*

Krug, R.M. and Richardson, D.M. Biocontrol agents, aliens and energy. *Fynbos Forum: 'Fynbos and human heritage'. Still Bay, June 2011.*

Lyons, C-L., Coetzee, M., Terblanche, J.S. and Chown, S.L. Comparing temperature tolerances of two strains of the malaria vectors *Anopheles arabiensis* and *An. funestus*. *XVII Congress of the Entomological Society of Southern Africa, Bloemfontein, July 2011.*

Lyons, C-L., Coetzee, M., Terblanche, J.S. and Chown, S.L. Development rate and temperature relationships of two malaria vectors, *Anopheles arabiensis* and *An. funestus*. *Joint conference of the Zoological Society of Southern Africa and the Parasitological Society of Southern Africa, Stellenbosch, July 2011*.

McGeoch, M.A., Spear, D., Van Wilgen, N.J. and Foxcroft, L. Monitoring invasive alien animals in protected areas. *Fynbos Forum Programme, Theme: Fynbos and human heritage*. *Still Bay, June 2011.*

Modiba, R.V. and Foord, S.H. Response of benthic macroinvertebrates and adult odonata to alien invasive clearing. *4th Indibano of the SAEON Graduate Student Network (GSN) Assegai Trails, Eastern Cape, November 2011*.

Munyai, T.C. and Foord, S.H. How fast can you climb a mountain? Climate change, ant assemblages, and a centre of endemism. *4th Indibano of the SAEON Graduate Student Network (GSN) Assegai Trails, Eastern Cape, November 2011*.

Naude, M., Jacobs, S.M. and Esler, K.J. Fynbos riparian ecosystem biogeochemistry and IAPs. *Fynbos Forum, Still Bay, June 2011.*

Nottebroek, H., Esler, K.J. and Schurr, F.M. Effects of intraspecific and community density on the lifetime fecundity of long-lived Proteaceae shrubs. *Fynbos Forum, Still Bay, June 2011.*

Olds, A.A., Weyl, O.L.F., Smith, M.K.S. and Russell, I.A. The potential impact of freshwater fish introductions on a South African wetland of international importance, the Wilderness lakes system, Western Cape. *South African Society of Aquatic Science. Ithala Game Reserve, KwaZulu-Natal, June 2011.*

Olds, A.A., Weyl, O.L.F. and Smith, M.K.S. Distribution and abundance of alien invasive fish species in a South African RAMSAR wetland, the Wilderness Lakes. *South African Marine Science Symposium 2011. Estuarine, Coastal and Oceanic Ecosystems: Breaking Down the Boundaries. Grahamstown, April 2011.*

Prozesky, H.E. Who's who in the zoo? A review of South African environmental sociology since 2000. *XVII South African Sociological Association (SASA) Congress, July 2011.*

Rebelo, A.J., Le Maitre, D., Esler, K.J. and Cowling, R.M. The hydrological impacts of alien invasion and subsequent restoration: a case study of the Kromme River System, South Africa. *Fynbos Forum, Still Bay, June 2011.*

Sebola, A.P. and Ligavha-Mbelengwa, M.H. An assessment of the impact of alien plant invasion along the riparian zone: A case study of Luvuvhu, Lutanandwa and Mutshundudi rivers, Limpopo Province, South Africa. *South African Association of Botanists, Grahamstown, January 2011.*

Singels, E. and Esler, K.J. Habitat fragmentation effects on geophyte diversity in Strandveld on the west coast of South Africa. *Fynbos Forum, Still Bay, June 2011.*

Strydom, M., Esler, K.J., Wood, A.R. and Impson, F. Seed rain and seed bank status of *Acacia saligna* across a geographical gradient in South Africa. *Fynbos Forum, Still Bay, June 2011.*

Taylor, G.C. and Weyl, O.L.F. Age and growth of largemouth bass (*Micropterus salmoides*) in Wriggleswade Dam South Africa: Why are there so few large fish? *South African Society of Aquatic Science. Ithala Game Reserve, KwaZulu-Natal, June 2011.*

Thononda, D., Foord, S.H., Schoeman, C.S. and Dippenaar-Schoeman, A.S. Elevational gradients in epigeal spiders (Araneae) and beetles (Carabidae and Tenebrionidae) diversity across the Western Soutpansberg Mountain: space, area and environment. *4th Indibano of the SAEON Graduate Student Network (GSN) Assegai Trails, Eastern Cape, Sunday, November 2011.*

Van Wilgen, N.J., Baard, E.H.W. and Richardson, D.M. Risk assessment and trends in alien reptile and amphibian introductions. *CAPE Invasive alien animal working group, Tokai, November 2011.*

Wilson, J. R.U., Ivey, P. and the EDRR team. An overview of EDRR or 'the invasive species assessment and eradication programme' *39th Annual workshop on biological and integrated control of weeds, Bloemfontein, July 2011.*

Woodford, D.J., Weyl, O.L.F. and Hui, C. Investigating the riverscape ecology of fish invasions across an artificial irrigation network. *South African Society of Aquatic Science. Ithala Game Reserve, KwaZulu-Natal, June 2011.*

8.7.3 Poster presentations

International

Berthouly-Salazar, C., Hui, C., Le Roux, J.J., Van Rensburg, B.J. and Jansen van Vuuren, B. Morphological adaptations of the invasive Common myna in South Africa. *Ecological & Evolutionary Genomics, University of New England, United States of America. July 2011.*

Crous, C., Jacobs, S. and Esler, K.J. Vulnerability of selected native and invasive woody riparian species in the Fynbos Biome to cavitation. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Foxcroft, L.C., Richardson, D.M., Pyšek, P. and Genovesi, P. The ecology and management of invasive alien plants in protected areas. *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Geerts, S., Wilson, J.R.U., McGeoch, M.A., Gaertner, M., Le Roux, J.J., Kritzinger-Klopper, S., Muofhe, C. and Richardson, D. M. *Banksia ericifolia* invading South Africa as predicted — a major threat or just symptom of a peculiar fire regime? *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Jacobs, S., Booi, N., Bekker, S., Ellis, F., Esler, K.J., Hoffman, E., Milton, S. and Strever, A. Landscape Legacies: Biogeochemical and ecohydrological properties of natural and cultivated 'heuweltjies' (mima-like mounds) of the fynbos and succulent karoo in South Africa. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

Kaplan, H., Wilson, J.R.U., Richardson, D.M. and Le Roux, J.J. Predicting spread pathways and population growth of an emerging invader, *Acacia stricta*, in South Africa for potential eradication. *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Mgobozi, M., Somers, M.J. and Dippenaar-Schoeman, A. Spider responses to grazing in an African savannah. *25th International Congress for Conservation Biology, Auckland, New Zealand, December 2011.*

Reinecke, M.K., Esler, K.J. and King, J.M. Patterns of zonation in riparian scrub. *MEDECOS X11, Los Angeles, California, United States of America, September 2011.*

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Vardien, W., Le Roux, J.J., Richardson, D.M., Foxcroft, L.C. and Wilson, J.R.U. Unravelling the spatial dynamics of *Lantana camara* invasions in Kruger National Park, South Africa using a genetic approach. *11th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi), Szombathely, Hungary, August 2011.*

Woodford, D.J., Hui, C. and Weyl, O.L.F. Modeling the riverscape ecology of fish invasions across an artificial irrigation network. *American Fisheries Society, Seattle, September 2011.*

Zylstra, M., Knight, A., Esler, K.J. and Le Grange, L. Meaningful nature experiences: reconnecting society with a conservation ethic. *25th International Congress for Conservation Biology, Auckland, New Zealand, December 2011.*

National

Huchzermeyer, C.F., Weyl, O.L.F. and Cowley, P.D. Evaluation of acoustic transmitter implantation and determination of post-translocation behaviour of largemouth bass *Micropterus salmoides* (Lacepède, 1802). *South African Society of Aquatic Science. Ithala Game Reserve, KwaZulu-Natal, June 2011.*

Jansen, W., Van Rensburg, B.J., Robertson, M.P. and Dippenaar-Schoeman, A. Ground dwelling arachnid diversity along an altitudinal gradient; a basis for exploring ecological patterns. *Proceedings of the African Arachnological Colloquium (10th Congress), Mookgopong, February 2011.*

Raine, K., Hayward, M. and Somers, M.J. The impact of climate change on predator prey preference. Southern *African wildlife management Symposium the human-natural resource interface: reconciling conflicting trade-offs? Hartenbos, September 2011.*

Rebelo, A.J., Le Maitre, D., Esler, K.J. and Cowling, R.M. The water use of palmiet: *Prionium serratum*. *Fynbos Forum, Still Bay, June 2011.*

Sandberg, R., Esler, K.J., Allsopp, N. and Bond, W.J. Which fragments will survive? Minimum viable fynbos patch size under global change pressures of habitat fragmentation. *Fynbos Forum, Still Bay, June 2011.*

Schirrmann, M.K., Swartz, E.R. and Weyl, O.L.F. Genetic identification of alien black bass species (*Micropterus* spp.) in South Africa. *South African Society of Aquatic Science. Ithala Game Reserve, KwaZulu-Natal, June 2011.*

Schmidt, B., Nottebrock, H., Esler, K.J., Bohning-Gaese, K., Schurr, F. and Schleuning, M. The spatial interactions in Protea communities and their relations to pollinator behaviours. *Fynbos Forum, Still Bay, June 2011.*

Singels, E., Esler, K.J., Witthuhn, C. and Cowling, R.M. The influence of geophytes on modern human evolution. *Fynbos Forum, Still Bay, June 2011.*

Strydom, M., Esler, K.J., Wood, A.R. and Impson, F. Seed rain and seed bank status of *Acacia saligna* across a geographical gradient in South Africa. *39th Annual workshop on biological and integrated control of weeds. University of the Free State, Bloemfontein, July 2011.*

Van Tonder, G., Swanepoel, L., Dalerum, F. and Somers, M.J. A habitat suitability approach to predict the occurrence of leopards *Panthera pardus* in South Africa. *Southern African wildlife* management *symposium the human-natural resource interface: reconciling conflicting trade-offs? Hartenbos, September 2011.*

Tucker, C.M., Knight, A.T., Esler, K.J. and Allsopp, N. Sustainability indicator development for UNESCO Biosphere Reserves. *Fynbos Forum, Still Bay, June 2011.*

8.8 Other relevant outputs

8.8.1 Popular articles and talks

Articles

Anonymous. 2011. Boek oor indringers wyd gelees. *Landbouweekblad*, Maart 2011, pp. 106.

Anonymous. 2011. Stellenbosch University researchers combine forces. *Borehole Water Journal*, June 2011, Vol.84. pp. 2.

Anonymous. 2011. Africa's first meeting of Antarctic experts. *ScienceAfrica*. August/September 2011, pp. 17.

Anonymous. 2011. Award for work on malaria vectors and climate change. *ScienceAfrica*. August/September 2011, pp. 19.

Coetsee, J. 2011. Let op vir die gestreepte rietpadda. *Landbouweekblad*, Januarie 2011, pp. 78.

Crous, C., Jacobs, S.J. & Esler, K.J. 2011. Conserving our rivers: a meander. *Quest* 7(4), pp. 10.

Duvenage, E. 2011. Fifty years of Invasion Ecology: The legacy of Charles Elton. *Game and Hunt*, May 2011, pp. 45.

Jansen van Vuuren, B. 2011. Misconceptions regarding the sable. *Wildlife Ranching*, pp. 7.

Measy, G.J. & Davies, S.J. 2011. Struggling against domestic exotics at the southern end of Africa. *Froglog*, July 2011, Vol. 97. pp. 28.

Norval, J. 2011. Insekkundiges byeen. *Landbouweekblad*, Julie 2011, pp. 97.

Talks

Chown, S.L. *The Road to Cop17. Confronting the consequences of climate change.* Inaugural National Research Foundation Science for Society Lecture, Pretoria, October 2011.

Chown, S.L. *Informatics as an approach for understanding biodiversity in the Antarct*ic. Invited speaker at Antarctica New Zealand, Christchurch, New Zealand, August 2011.

Chown, S.L. *Lion Griefs in the Shade: Global Change Biology in the Antarctic.* 9th S.T. Lee Lecture, Victoria University of Wellington, New Zealand, September 2011.

Chown, S.L. *Macrophysiology – a unified approach for understanding biodiversity in a changing world.* Invited speaker at the Australian Antarctic Division, Hobart, Australia, August 2011.

Chown, S.L. *The Antarctic Treaty System.* Presentation to the attendees of the SANAP Antarctic Science Winter School, Hermanus, July 2011.

Clusella-Trullas, S. *Are global patterns of physiology useful?* CapeHerp Meeting, Stellenbosch, South Africa, March 2011.

Esler, K.J. *Diversification and growth of the postgraduate student corps and postdoctoral fellow.* Stellenbosch University Research Indaba, STIAS, July 2011.

Esler, K.J. *Ecology of Academia*. University of the third age (UA3), Hermanus, May 2011.

Esler, K.J. *Road verges: assets or liabilities*. Kogelberg Branch of the Botanical Society, Betty's Bay, September 2011.

8.9 NRF service provision

8.9.1 Rating and project proposal reviews

Focus Area and panel reviews

Competitive programme for rated researchers
Competitive support for unrated scientists (2)
Incentive funding project proposal reviews (2)
NRF South African National Antarctic Programme Project Proposal Reviews (2)
SEAChange: project proposal review
South Africa / Zambia research partnership programme
South Africa / Japan research partnership programme
South Africa / Namibia research partnership programme
South African Biosystematics Initiative
Thuthuka: project proposal review

Competitive Programme for Rated Researchers

2 Completed

Research Scholarship Evaluations

6 Completed

Rating Reviews

6 Completed

8.9.2 Panel and committee service

Plant sciences rating panel
South African Research Chairs Initiative Review Panel
SEAChange Evaluation Panel

8.10 Media interactions

8.10.1 Newspaper articles

Anonymous. 2011. Knowledge creation is key. Mail & Guardian, 2 September 2011.
Anonymous. 2011. Annals of Antarctica just a click away. Monday Paper, 8 August 2011.

Anonymous. 2011. Biodiversity of South has changed. Die Burger (Oos Kaap Landbou), 27 April 2011.
Anonymous. 2011. Invasive species expert honoured. Bolander, 30 November 2011.
Anonymous. 2011. That annoying buzz and what it may mean for your risk of malaria. Business Day, 23 November 2011.
Anonymous. 2011. Women create hope through expertise. Cape Argus, 6 August 2011.
Anonymous. 2011. Pines on Stellenbosch Mountain are invasive. Eikestadnuus, 5 August 2011.
Anonymous. 2011. Future stars. Mail & Guardian, 8 December 2011.
Anonymous. 2011 Maths ecologist recognised. Eikestad News, 22 April 2011.
Anonymous. 2011. Vroue skep hoop deur kundigheid. Die Burger, 6 August 2011.
Anonymous. 2011. Muskiete gee haar wenprys. Tygerburger (Brackenfell), 3 August 2011.
Anonymous. 2011. Robjagters dalk eerste hier. Volksblad (Noord Kaap), 19 March 2011.
Anonymous. 2011. Student wen prys vir malaria-navorsing. Die Matie, 27 July 2011.
Anonymous. 2011.Wen prys met muskiete. Tygerburger (Durbanville), 3 August 2011.
Bega, S. 2011. Invasive aliens a threat to Antarctica. Sunday Weekend Argus, 16 October 2011.
Bega, S. 2011. Scientists could be introducing Antarctic aliens. Saturday Star. 15 October 2011.
Bega, S. 2011. South Africans recall braais in frozen Antarctica. Saturday Star, 30 July 2011.
Carnie, T. 2011. Halt – it's the seed police. Mercury, 23 March 2011.
Carnie, T. 2011. Island forecasts bad weather for the world. Pretoria News, 22 March 2011.
Carnie, T. 2011. The ticking bomb of global warming. Mercury, 21 March 2011.
Duvenage, E. 2011. Lees alles oor biologiese indringers. Die Burger (Buite), 8 March 2011.
Kelly, B. 2011. Future Stars. *Mail & Guardian*, 2 Septempber 2011.
La Vita, M. 2011. Medalje vir 'n boom-man. Die Burger (Kaap Stedelik), 16 December 2011.
MacGregor, D. 2011. Climate change taking place at fast rate. Daily Dispatch, 15 March 2011.
Maditla, N. 2011. Restoring the fynbos has many benefits. Cape Argus, 8 September 2011.
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Schoeman, A. 2011. Nuwe basis op Marioneiland geopen. Die Burger (Oos Kaap), 21 March 2011.
Schoeman, A. 2011. SA-eiland se nuwe hotel. Die Burger (Kaap), 12 March 2011.
Schoeman, A. 2011. SA-eiland se nuwe hotel. Die Burger (Oos Kaap), 12 March 2011.
Staff Reporter. 2011. FS University gets bugged. Citizen (Freestate), 6 July 2011.
Van Den Berg, S. 2011. Biologist honoured. Eikestadnuus, 25 November 2011.
Van Wilgen, B.W. 2011. Don't beat about the bush in this debate where biodiversity is the bottom line: The carbon and other recreational benefits of pines are tiny. Cape Times, 25 February 2011.
Venter, M. 2011. Bioloog van SU vereer vir sy bydrae. Die Burger (Kaap Platteland), 18 November 2011.
Venter, M. 2011. Bioloog van SU vereer vir sy bydrae. Die Burger (Suid Kaap), 18 November 2011.
Yeld, J. 2011. Chain of killing brings dirty island full circle. Sunday Independent, 27 March 2011.
Yeld, J. 2011. Climage-change misery on our doorstep. Daily News, 25 November 2011.

Yeld, J. 2011. Marion Island's new base to open tonight. Daily News, 18 March 2011.
Yeld, J. 2011. Minister sets sail to open new Marion Island base. Daily News, 14 March 2011.
Yeld, J. 2011. Now Cape is hopping with whistling frogs. Cape Argus, 19 January 2011.
Yeld, J. 2011. The good, the bad and the ugly of aliens in South Africa. Cape Argus, 2 November 2011.
Yeld, J. Historian brings Antarctica story in from the cold. Cape Argus, 23 February 2011.

8.10.2 Newsletters

Anonymous. 2011. New books: Alien & Invasive Animals. SANSA Newsletter. June–November 2011.

8.10.3 Articles published by Stellenbosch University

Duvenage, E. 2011. Tackling the interface between ecology, mathematics. *Kampusnuus*. 21 February 2011.
Anonymous. 2011. NRF honours SU academics. *Kampusnuus*. 7 September 2011.
Rippenaar, L. 2011. Eerste Suid Afrikaanse historikus op Antarktika. *Matieland*. 20 July 2011.
Thompson, D. 2011. Book review: Encyclopaedia of biological invasions. *Matieland*. 20 July 2011.

8.10.4 Electronic resources

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8.10.5 Radio and television

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Chown, S.L. 2011. Interviewed by the Australian Broadcasting Company for television news about the sub-Antarctic during the Third International Forum on the sub-Antarctic, August 2011.

Chown, S.L. 2011. Interviewed on Radio New Zealand about global change and invasions in the Antarctic, with Chris Laidlaw, September 2011.

Du Plessis, D., Riffel, W. (Iimbovane educator), Stears, K. (Iimbovane educator). Interviewed on Radio Sonder grense concerning the educational value of the Iimbovane Outreach Project, on the programme *Ons en die Onderwys*, with Anthea Adams, May 2011.

Du Plessis, D. Interview on Channel Africa concerning the Iimbovane Project, on the programme *Africa Midday,* with Wandile Kallipa, November 2011.

Du Plessis, D. Interview on CapeTalk concerning the Iimbovane Outreach Project, *Redi Tlhabi's Green Tip of the Day*, with Redi Tlhabi, December 2011.

Du Plessis, D. Interviewed on the programme, *Befonk* on Radio Sonder Grense concerning the Iimbovane Outreach Project, with Christine Wessels, August 2011.

Hui, C. Interviewed on the programme *Science matters* on SAFM, with Christina Scott, March 2011.

Scott, D. Interviewed on Talk Radio 702 regarding the Antarctic Legacy Project, with Jenny Crwys-Williams, February 2011.

Scott, D. Interviewed on Radio Sonder Grense on the programme *Monitor*, concerning the Antarctic Legacy Project, July 2011.

Scott, D. Interviewed on Radio Sonder Grense on the programme *Reis sonder Grense*, concerning the Antarctic Legacy Project, September 2011.

9 Stage progress

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

Time frames:
The pending Gate review (Gate 4) shall take place during February or March 2012.
A Board meeting is scheduled for 15 March, during which the gate review will take place.

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
2010: Board meetings took place on 16 March and 9 November
2011: Board meetings took place on 16 March and 25 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)
2010: Student lists submitted on 3 May (provisional) and 17 September (final)
2011: Student lists submitted on 20 April (provisional) and 15 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
2010: Nuggets submitted on 15 June 2010 and 24 August 2010
2011: Nuggets submitted on 30 March 2011, 23 June 2011 and 19 October 2011

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 2010
2010: Audited statements were presented to the Board on 16 March 2011
2011: Audited statements will be presented to the Board on 15 March 2012

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
2010: Cash flow statements for January to December submitted on schedule
2011: 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
2010: Annual Report completed
2011: Annual Report completed

The CoE shall submit a Statement of Compliance by no later than March 2012 referring to Stage 4.
The statement of compliance for Stage 4 was signed at the Board meeting held on 15 March 2012.

Standard Output Targets per annum in the Current Stage:
Total number of students supported ≥ ***50*** on average per annum
2009: 69 incl. post-docs
2010: 75 incl. post-docs
2011: 86 incl. post-docs

Woman students ≥ ***50***% of all students on average per annum
2009: 37 (54%)
2010: 45 (60%)
2011: 46 (53%)

Black students ≥ ***50***% of all students on average per annum
2009: 27 (39%)
2010: 32 (43%)
2011: 40 (47%)

Number of social science students ≥ ***2*** on average per annum
2009: 2
2010: 2
2011: 2

Average duration of submitted Masters degrees (post Honours) ≤ ***2.5*** years at end of stage
2004-2011: 2.5 years

Average duration of submitted Ph.D. degrees (post Masters) ≤ ***3.5*** years at end of stage
2004-2011: 3.5 years

Average duration of submitted Ph.D. degrees (upgraded from Masters) ≤ ***5*** years at end of stage
2004-2011: 4 years

Post-doctoral researcher ≥ ***10***% of all students at end of stage
2009-2011: 19% (43)

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
2010: 31
2011: 33

Number of patents ≥ ***0***
2009: 0
2010: 0
2011: 0

Number of peer reviewed publications ≥ ***60*** on average per annum
2009: 92
2010: 93
2011: 120

Number of peer reviewed publications ≥ ***1*** with an impact rating of ≥ ***15*** on average per annum
2009: 1
2010: 2
2011: 3

Number of peer reviewed publications ≥ ***10*** with an impact rating of ≥ ***3.5*** on average per annum
2009: 26
2010: 26
2011: 39

Number of national conference presentations ≥ ***20*** on average per annum
2009: 40 (6 invited, plenary and keynote; 22 oral; 12 poster)
2010: 27 (4 invited, plenary and keynote; 11 oral; 12 poster)
2011: 44 (3 invited, plenary and keynote; 30 oral; 11 poster)

Number of international conference presentations ≥ ***10*** on average per annum
2009: 63 (5 invited, plenary and keynote; 45 oral; 13 poster)
2010: 40 (3 invited, plenary and keynote; 31 oral; 6 poster)
2011: 44 (4 invited, plenary and keynote; 28 oral; 12 poster)

Number of joint venture student training initiatives ≥ ***20*** on average per annum
2009: 30 (15 Academy students; 15 co-supervisions)
2010: 46 (15 Academy students; 31 co-supervisions)
2011: 40 (14 Academy participants; 26 co-supervisions)

Number of local conferences organized ≥ ***1*** at end of stage
2009-2011: 1 (WfW/EDRR course, October 2010)

Number of international conferences organized ≥ ***1*** at end of stage
2009-2011: 3 (10th International Conference in the Ecology and Management of Plant Invasions, August 2009; Acacia Workshop, October 2010; 7th Scientific Committee on Antarctic Research History Workshop 'Antarctic history: probing the unknown' July 2011)

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
2010: Annual Research Meeting held on 18 and 19 November; all CTMs attended
2011: Annual Research Meeting held on 10 and 11 November; 3 CTMs were unable to 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.
2010: The project was successfully implemented in 18 new full participation schools and 10 new subscription schools.
2011: No new schools were added; involvement was maintained with the 28 schools which are involved in the project.

10 Conclusion

The Centre for Invasion Biology continues to perform at an exceptional elevel, having met and exceeded almost all of its targets for the past Service Level Agreement period. Although 2011 was a year marked by uncertainty, mostly as a consequence of funding matters, excellent future plans have been developed and several key funders have re-expressed their interest in maintaining the productive partnerships. The C·I·B can rightly be considered an excellent investment by all its partners, delivering globally competitive research, excellent human resources, award-winning community engagement and significant service in an integrated manner.

11 Finances

Audited financial statements provided by PriceWaterhouse Coopers (attached).

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS - 31 DECEMBER 2011

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2011

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

.....

.....2012
DATE

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF FINANCIAL POSITION AT 31 DECEMBER 2011

	Notes	2011 R	2010 R
ASSETS			
NON-CURRENT ASSETS		1 048 787.48	933 736.85
Equipment and vehicles	2	1 048 787.48	933 736.85
CURRENT ASSETS		2 517 156.37	2 083 373.81
Trade and other receivables	3	37 602.62	107 535.85
Stellenbosch University	4	2 479 553.75	1 975 837.96
TOTAL ASSETS		**3 565 943.85**	**3 017 110.66**
EQUITY AND LIABILITIES			
CAPITAL AND RESERVES		3 165 081.46	2 658 572.77
Accumulated funds		3 165 081.46	2 658 572.77
CURRENT LIABILITIES		400 862.39	358 537.89
Trade and other payables	5	400 862.39	358 537.89
TOTAL FUNDS AND LIABILITIES		**3 565 943.85**	**3 017 110.66**

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER 2011

	Notes	2011 R	2010 R
Revenue		7 767 276.00	7 748 899.00
Other income		5 260 496.48	4 405 734.06
Operating expenses	7	(12 728 912.09)	(12 667 355.09)
Operating loss		298 860.39	(512 722.03)
Finance income		208 000.12	171 071.88
Finance cost		(351.82)	(277.13)
Surplus/(loss) for the year		506 508.69	(341 927.28)
Other comprehensive income		-	-
Total comprehensive income/(loss) for the year		506 508.69	(341 927.28)

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 DECEMBER 2011

	2011 R	2010 R
ACCUMULATED FUNDS		
At the beginning of the year	2 658 572.77	3 000 500.05
Total comprehensive income/(loss) for the year	506 508.69	(341 927.28)
At the end of the year	**3 165 081.46**	**2 658 572.77**

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 31 DECEMBER 2011

	2011 R	2010 R
CASH FLOWS FROM OPERATING ACTIVITIES		
Net surplus/(loss) for the year	506 508.69	(341 927.28)
Adjustment for:		
Interest received	(208 000.12)	(171 071.88)
Interest paid	351.82	277.13
Exchange rate loss	-	428.02
Depreciation	428 463.97	455 437.71
Profit on sale of equipment and vehicles	(62 955.73)	-
Operating profit/(loss) before working capital adjustments	664 368.63	(56 856.30)
Working capital adjustments	112 257.73	586 900.58
Decrease in trade and other receivables	69 933.23	544 953.10
Increase in trade and other payables	42 324.50	41 947.48
Cash generated from operations	776 626.36	530 044.28
Interest received	208 000.12	171 071.88
Interest paid	(351.82)	(277.13)
NET CASH FLOWS FROM OPERATING ACTIVITIES	984 274.66	700 839.03
CASH FLOWS FROM INVESTMENT ACTIVITIES		
Equipment and vehicles purchased	(543 713.87)	(236 910.80)
Proceeds on the sale of fixed assets	63 155.00	-
Increase in amount owed by Stellenbosch University	(503 715.79)	(463 928.23)
NET CASH FLOWS FROM INVESTMENT ACTIVITIES	(984 274.66)	(700 839.03)
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 2011

1. ACCOUNTING POLICY

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

EQUIPMENT AND VEHICLES

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

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

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

IMPAIRMENT OF ASSETS

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

TRADE AND OTHER RECEIVABLES

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

TRADE AND OTHER PAYABLES

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

FINANCIAL INSTRUMENTS

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

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

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

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

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

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

1. ACCOUNTING POLICY (continued)

INCOME RECOGNITION

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

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

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

FOREIGN CURRENCY TRANSLATION

(a) Functional and presentation currency

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

(b) Transactions and balances

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

STANDARDS, INTERPRETATIONS AND AMENDMENTS NOT YET EFFECTIVE

The following standards and amendments to existing standards have been published and are mandatory for the centre's accounting periods beginning on or after 1 January 2012 or later periods, but which the centre has not early adopted.

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

Amendments to AC138, 'First time adoption' on hyperinflation and fixed dates (1 July 2011)
Amendment to AC144 Financial Instruments: Disclosures – Transfer of financial assets (1 July 2011)
Amendment to AC 144 Financial Instruments: Disclosure (1 January 2013)
Amendment to AC102,'Income taxes' on deferred tax (1 January 2012)
Amendments to AC 101, 'Presentation of Financial Statements', on presentation of items of OCI (1 July 2012)
Amendments to AC 116, "Employee benefits" (1 January 2013)
AC146, Financial Instruments (2009 and 2010) (1 January 2013)
Amendments to AC 146, Financial Instruments (2011) (1 January 2015)
AC 132 (revised 2011), Separate financial statements (1 January 2013)
AC 110 (revised 2011), Associates and joint ventures (1 January 2013)
Amendments to AC 125, Financial Instruments: Presentation (1 January 2014)

CRITICAL ACCOUNTING ESTIMATES AND JUDGEMENTS

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

Useful lives of assets

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

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

2. EQUIPMENT AND VEHICLES

	Equipment R	Vehicles R	TOTAL R
31 December 2011			
Carrying amount at the beginning of the year	582 355.44	351 381.41	933 736.85
Cost	2 330 668.04	371 822.10	2 702 490.14
Accumulated depreciation	(1 748 312.60)	(20 440.69)	(1 768 753.29)
Additions during the year	387 400.41	156 313.46	543 713.87
Disposals	(199.27)	-	(199.27)
Cost	(140 708.53)	-	(140 708.53)
Accumulated depreciation	140 509.26	-	140 509.26
Depreciation for the year	(354 099.55)	(74 364.42)	(428 463.97)
Carrying amount at the end of the year	711 057.03	337 730.45	1 048 787.48
Cost	2 672 959.92	432 535.56	3 105 495.48
Accumulated depreciation	(1 961 902.89)	(94 805.11)	(2 056 708.00)
31 December 2010			
Carrying amount at the beginning of the year	726 517.93	425 745.83	1 152 263.76
Cost	2 103 268.82	371 822.10	2 475 090.92
Accumulated depreciation	(1 376 750.89)	53 923.73	(1 322 827.16)
Additions during the year	236 910.80	-	236 910.80
Disposals	-	-	-
Cost	(9 511.58)	-	(9 511.58)
Accumulated depreciation	9 511.58	-	9 511.58
Depreciation for the year	(381 073.29)	(74 364.42)	(455 437.71)
Carrying amount at the end of the year	582 355.44	351 381.41	933 736.85
Cost	2 330 668.04	371 822.10	2 702 490.14
Accumulated depreciation	(1 748 312.60)	(20 440.69)	(1 768 753.29)

3. TRADE AND OTHER RECEIVABLES

	2011 R	2010 R
Trade receivables	35 302.97	40 236.20
Prepaid expenses	-	65 000.00
Other	2 299.65	2 299.65
	37 602.62	107 535.85
The ageing of these receivables are as follows:		
Up to 2 months	35 302.97	-
2 to 6 months	-	40 236.20
	35 302.97	40 236.20

4. STELLENBOSCH UNIVERSITY

The loan to Stellenbosch University is not secured and is subject to interest rates linked to prime. The rate at 31 December 2011 was 7.00% (2010: 7.00%). The loan has no fixed terms of repayment.

	2011 R	2010 R
5. TRADE AND OTHER PAYABLES		
Leave pay provision	342 986.30	274 919.92
Other creditors	3 891.09	37 789.97
Provision for audit fees	53 985.00	45 828.00
	400 862.39	358 537.89

6. INCOME TAX

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

7. OPERATING EXPENSES

Operating expenses includes the following disclosable amounts:

Audit fees - audit	53 985.00	45 828.00
Depreciation	428 463.97	455 437.71
Foreign exchange loss	-	428.02
Salaries	5 708 565.20	4 353 142.55

8. FINANCIAL INSTRUMENTS

Foreign currency management and exposure

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

Liquidity risk

Liquidity is managed by monitoring forecast cash flows.

Credit risk management

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

Cash flow and fair value interest rate risk

As at 31 December 2011 and 2010, if the interest rate had been 100 basis points higher/lower and all other variables held con-stant, the centre's profit/(loss) would have increased/decreased as a result of interest received on loans by R24 795.54 (2010: R19 758.38). The other financial instruments are not exposed to interest rate risk.

8. FINANCIAL INSTRUMENTS (continued)

Fair values

At 31 December 2011 and 2010 the carrying amounts of receivables, loans and payables approximated their fair values due to the short-term maturities of these assets and liabilities.

	Carrying value	Contractual cash flows	< 1 year	1 - 5 years	> 5 years
	R	R	R	R	R
Financial liabilities					
31 December 2011					
Trade and other payables	400 862.39	400 862.39	400 862.39	-	-
Net financial liabilities	400 862.39	400 862.39	400 862.39	-	-
31 December 2010					
Trade and other payables	358 537.89	358 537.89	358 537.89	-	-
Net financial liabilities	358 537.89	358 537.89	358 537.89	-	-

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.

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DETAIL INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2011

	2011 R	2010 R
INCOME	13 235 772.60	12 325 704.94
Interest received	208 000.12	171 071.88
National Research Foundation grant	7 767 276.00	7 748 899.00
Other income	5 196 662.36	4 405 734.06
Foreign exchange profit	878.39	-
Profit on sale of equipment	62 955.73	-
EXPENDITURE	12 729 263.91	12 667 632.22
Operational expenses	7 020 698.71	8 314 489.67
Advertisements	22 214.38	28 738.91
Audit fees - current year	53 985.00	45 828.00
- previous year underprovision	-	3 798.60
Consumables	91 661.58	90 424.94
Consultation	-	4 311.72
Copying and stationery	28 650.73	51 844.43
Depreciation	428 463.97	455 437.71
Entertainment	6 172.41	2 290.64
Foreign exchange loss	-	428.02
Interest paid	351.82	277.13
Insurance	3 389.48	4 575.00
Levies	150 940.58	186 533.62
Membership and affiliation fees	25 943.30	30 399.47
Non-capitalised books	3 961.31	-
Small capital works: not capitalised	20 497.92	29 620.15
Postage, telephone and fax	87 896.54	72 565.87
Safety clothing	3 885.44	5 992.76
Rent paid for facilities	-	4 800.00
Repairs	79 386.13	9 574.37
Software and internet	31 344.26	31 569.55
Sundry expenses	82 774.09	17 497.08
Team member research costs	5 204 623.46	6 483 756.15
Transport and accommodation	528 833.97	632 529.34
Workshops	165 722.34	121 696.21
Personnel expenses	5 708 565.20	4 353 142.55
Salaries	5 708 565.20	4 353 142.55
SURPLUS/(LOSS) FOR THE YEAR	506 508.69	(341 927.28)