

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL PROGRESS REPORT 2012













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March 2013

Cover page photo: The C·I·B team (staff, core team, post-doctoral associates, students and partners) at the Annual Research Meeting held in November 2012.

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ANNUAL REPORT 2012

Reporting period from 1 January 2012 to 31 December 2012

Identification

Name of Director		Prof. David M. Richardson*
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: 14 March 2013
	:	Financials: 28 March 2013

*From 1 May 2012 upon resignation of former Director, Prof. Steven L. Chown

Summary of progress against our five Key Performance Areas (KPAs).

Research

The C·I·B's capacity has been extended by the addition of new core team members, and also by new research associates (including former C·I·B director Prof. Steven Chown and core team member Prof. Melodie McGeoch, who wished to retain a professional relationship with the Centre). These additional research associates ensure that a broader range of invasion biology expertise can address any issue; also, the research associates span the globe and thus bring perspective and corroboration along with their extensive knowledge.

Education and Training

In 2012, 92 students registered with the C·I·B, of whom 51 were women. Seventeen Honours students; 34 Masters students; 36 PhDs and ten post-docs pursued research projects at the C·I·B; 76 of whom were South African while 19 were foreign. 54 of our registrants were black; 43 were white. In line with our commitment to inter-disciplinarity, two of these registrants pursued social science studies.

Thirty-two students completed their studies in 2012 (17 men and 15 women), including students who registered in previous years. The completions were at the following levels: ten Honours; seven Masters; 11 PhDs and four post-docs. Nineteen of the graduates were black students, twelve of whom are South African.

Three of our PhD students were rewarded for their outstanding science communication skills at the 'New Voices in Science' event held in Stellenbosch. Seventeen graduates and post-docs were employed in positions in the biodiversity field in South Africa and abroad.

Networking

During 2012 the network of the C·I·B was greatly expanded, with additions to the core team and the research associate group. In addition, two new MOUs were signed with important local and international partners, and our proposed five-year collaboration with Working for Water/NRMP was approved; the research will begin in earnest in 2013.

Information Brokerage

In addition to a scientific book and six book chapters, the C·I·B published 103 papers in peerreviewed journals. The C·I·B's Information Retrieval and Submission System (IRSS) now contains a total of 779 items, including 602 publications and 177 projects datasets, theses and student outputs.

Service Provision

Our core team members render services in their disciplinary fields via editing national and international journals; evaluating peer nominees for academic posts; reviewing post-graduate theses; providing expert advice to local, governmental and international panels and committees. We contribute to 21 national panels and committees ranging from nature reserve advisory boards to research advisory panels, and advise a selection of non-governmental organisations such as Earth for Elephants and Endangered Wildlife Trust as well as twelve international groups. The C·I·B hub provided advice to the Department of Environmental Affairs on risk assessment for alien species.

What was the gender impact of the $C \cdot I \cdot B$'s work?

The C·I·B's gender impact continues to expand. The majority of our student body is composed of women students, and they consistently excel in research. In 2012, two women PhD students were awarded prizes for science communication. Another PhD student received a travel grant to attend a conference and present her work overseas.

Red Flags

The Centre's student and support system includes both a general and an open bursary programme, in which students from partner institutions and other universities around SA are included. Recruitment efforts consist of visits by the Director and Deputy Director to various institutions each year, webbased advertisements, and posters and brochures circulated to all universities in SA. Despite these efforts the C·I·B experiences a shortage of qualified previously disadvantaged applicants, and in some years we have been unable to fill all our bursary positions. Applications received in 2012 for the 2013 year included only four PhD applications, and we subsequently issued a second bursary call to core team members, but to date have not been able to fill all the 2013 positions.

General Comments

Having completed our second Self-Evaluation Report wherein the C·I·B revisited progress over a further $4\frac{1}{2}$ year period, we can say with confidence that the C·I·B remains an industry leader in research into the impact of invasions, and the impact thereof on people's lives.

For the continued support which empowers our research, we thank the Department of Science and Technology, the National Research Foundation, Stellenbosch University, the Working for Water Programme of the Department of Environmental Affairs, the South African National Biodiversity Institute, the University of Pretoria and all of our partners and collaborators.

1 Scientific Research

1.1 Objectives

The C·I·B's research focusses on 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. The C·I·B's Strategic Plan for the period 2012-2014 details the rationale for research priorities for long-term and short-term research projects. Permanent transects in three of South Africa's mountain ranges currently make up the bulk of the C·I·B's long-term research. Short-term research priorities are grouped under the following major headings: biodiversity foundations; acacias as model systems for understanding invasions and impacts; detection, demonstration, responses and remediation; global environmental change and ecosystem services; and human dimensions. Another major heading included in this report is 'molecular methods as a tool in invasion science'. The latter theme was recognized as a fundamental component of the C·I·B's research tool box and merits a separate heading. This annual report provides a few examples of research highlights under the above headings. Further details of many research projects are given on the C·I·B's web site, <u>http://academic.sun.ac.za/cib/</u>.

The projects summarized below reflect investigations across a wide range of disciplines, taxa, and spatial and temporal scales that embrace and a variety of scientific approaches. As in previous years C·I·B research spans the range from basic to applied science. The overarching goal is to undertake world-class research in biology that draws on South Africa's unique biodiversity heritage and environmental problems, with a strong focus on providing practical solutions to these problems. The reports that appear below deal largely with research outputs that were formally published in 2012.

1.2 Progress

1.2.1 Long-term research

LONG-TERM CHANGE IN INSECT ASSEMBLAGES

The C·I·B has established three long-term transects in a representative sample of mountain gradients through Fynbos, Grassland and Savanna Biomes, with standardized and replicated sampling protocols that will allow comparative analysis once data collection has spanned a five- to ten-year period. The Soutpansberg elevational transect in the Limpopo province was initiated in September 2011 and is aimed at identifying the response of biological communities to environmental change in this east-west trending mountain range. This transect currently includes a data sequence stretching to January 2013 of biannually sampled invertebrates as well as associated environmental variables such as temperature and habitat structure. Eleven elevational zones (at intervals of 200 m) are sampled across the northern and southern aspects of the mountain. Although predominantly savanna, the transect also includes forest, thicket, grassland and some fynbos elements. An example of the utility of this data for answering fundamental ecological questions is the study by Munyai & Foord (2012. J Insect Conserv 16, 677-695). This paper from the MSc project of Caswell Munyai highlighted the importance of temperature in structuring ant assemblages across the mountain and provided baseline data for a predictive model of ant responses to climate change. Ants on the two aspects of the range are expected to contrast in their responses to climate change, with ants in the arid woodlands of the northern aspect moving up-slope while assemblages on the southern slope respond to the indirect effects of CO₂ induced bush encroachment.

LONG-TERM CHANGES TO THE PRINCE EDWARD ISLANDS ECOSYSTEM

The Antarctic and Southern Ocean islands provide ideal models for testing various hypotheses about the distribution of species and their genetic variation. Regarding the biogeography of the region, much is known about the marine systems, but much less about terrestrial systems. For the Prince Edward Islands, specifically Marion Island, we are beginning to appreciate that the spatial distribution of genetic variation at the island scale is highly complex. Specifically, the patterns observed today are shaped by climatic changes (such as glaciation events) and volcanic eruptions. A paper by Mortimer *et al.* (2012. *Biol J Linn Soc* 105, 131-145) described for the first time spatial segregation across a large geological lineament that runs across the island. The mite *Halozetes fulvus* was used as a model to test the effect that this geological discontinuity has on the spatial distribution of genetic diversity. Based on sequence data generated for 291 specimens, the authors showed how genetic diversity is structured across the island. Although diversity is not structured across the northern section of the lineament, Long Ridge, it is structured across the southern section, an area which includes the Santa Rosa Valley. The presence of the lineament adds another component to the already complex structure and processes that are known to affect diversity at the island scale, and allows hypotheses regarding spatial genetic variation to be refined and developed further.

To date, no work on genetic diversity has been conducted at fine spatial scales in the Prince Edward Islands. A paper by Born *et al.* (2012. *Mol Ecol* 21, 184-194) developed a sampling regime which allowed us to test hypotheses regarding gene flow and dispersal in the keystone cushion plant *Azorella selago*. A multidisciplinary approach combining isotropic and anisotropic approaches in a novel way revealed strong correlations between gene flow (specifically pollen dispersal) and prevailing wind directions.

While this sub-Antarctic research is a long-term project, it applies equally to the focus area 'global environmental change and ecosystem services' discussed below.

1.2.2 Short-term research

BIODIVERSITY FOUNDATIONS

Invasion dynamics of one of the world's worst weeds under the spotlight in South Africa

In order to manage invasive alien species more efficiently and use resources more wisely, detailed information on their distribution, invasion dynamics and introduction history is essential. Information on the traits of a species' biology and ecology, and the characteristics of the invaded environment, provides insight into the potential future range that may be occupied by the species. This is especially important for those species that are widely known to be highly invasive. *Lantana camara*, globally distributed throughout the tropics and sub-tropics, is an excellent example of one such species. C·I·B MSc student Waafeka Vardien and co-workers investigated the mechanisms driving the dispersal and invasion success of *L. camara* in South Africa. This study (Vardien *et al.* 2012. *S Afr J Bot* 81, 81-94) examined the dispersal of *L. camara* at national (biome and habitat) and regional scales (within the Kruger National Park [KNP]).

Lantana camara was first introduced into South Africa 155 years ago (1858) and on two occasions thereafter (1883 and 1885), although the diversity of cultivars indicates that other introduction events may have occurred. From those initial introductions over a century ago, *L. camara* was reported to occur in over two million ha in 1998, and at least 70 000 condensed ha. The number of biomes and habitats in which *L. camara* occurs is a clear indicator of its success as an invasive plant; however, bioclimatic modelling indicates the potential for still further spread within South Africa.

Lantana camara also possesses a large number of characteristics that predispose it to being highly invasive. These include, for example, being able to reproduce sexually and vegetatively, producing high numbers of seeds, flowering year round, and bearing fleshy fruit that is attractive to birds. Of

course, the nature of the region also provides an ideal environment within which to flourish, with high rainfall sub-tropical areas, large drainage networks, highly effective dispersers and a lack of any form of consumer pressure. When this environment is combined with drivers that promote further invasion (e.g. long residence time, propagule pressure and dispersal by humans for ornamental purposes) it is clear why *L. camara* has become so widespread and abundant in South Africa.

Protected areas are unfortunately not immune to the invasion and effects of alien species. *Lantana camara* was recorded in the KNP, South Africa's largest and oldest national park, in 1940, and is present in many of the park's rivers and drainage lines. In the KNP a number of sources appear to have played a role in its successful invasion, such as the presence of extremely large upstream catchment areas which are relatively heavily invaded by *L. camara*, its successful dispersal via the river network and its use as an ornamental plant. Fortunately KNP has instituted an extensive invasive species management programme over the last few decades, and appears to be maintaining *L. camara* at low levels.

Several species-specific traits, the suitability of South Africa's broad- and fine-scale environmental conditions and additional contextual specific drivers, make *L. camara* an 'ideal weed'. Detailed knowledge of these mechanisms, however, provides insight into what aspects may be exploited to develop appropriate management plans, whether mechanically, chemically or through biological control.

Dynamics of rodent-borne zoonotic diseases and their reservoir hosts in South Africa

Rats habitually live in close association with humans and their domesticated animals and are often highly abundant. This results in an increased risk of zoonotic disease transmission. Various routes of transmission exist, through rat bites, indirectly through environmental contamination by rat urine or faeces or through their ectoparasites that often act as vectors for diseases. This is of grave concern for immuno-compromised individuals, who are susceptible to opportunistic infections. Bacterial diseases such as leptospirosis, salmonellosis and plague occur widely and cause severe outbreaks with important socio-economic implications. In addition, many species of indigenous rodents are present in Africa and may act as reservoirs of these diseases, and play a significant role in disease transmission if interspecific exchanges occur. C·I·B student Rolanda Julius and co-workers used a molecular approach to investigate the prevalence, diversity and zoonotic potential of bacterial species of an invasive, commensal *Rattus* population and its public health implication in South Africa's Gauteng province (*Proc 25th Vert. Pest Conf.*).

All cryptic *Rattus* taxa were screened and sequenced to reveal that the species composition of rats in South Africa is almost evenly distributed between brown rats (*R. norvegicus*), black rats (*R. rattus*) and Pacific rats (*R. tanezumi*). Overall bacterial prevalence was found to be 62% in kidney samples from these rats. Bacterial taxa found included *Acinetobacter*, *Bartonella*, *Brochothrix*, *Rickettsia* and *Streptococcus* species, which are important potential zoonotic and food-spoiling organisms. In addition, data from the kidney samples suggested that *Rattus* plays a two-fold role in disease transmission: (a) through environmental contamination, and (b) by acting as a reservoir host of harmful bacteria. However, the bacterial load varies between different rat species; for example, *Streptobacillus moniliformis* prevalence was significantly lower in Pacific rats than in the other species. Phylogenetic analyses of *S. moniliformis* also revealed that some bacterial strains may be specific to a given rat species. The project also investigated an important *Rickettsia* organism which forms part of the typhus group, but this species was found to have a low prevalence in rats. In

summary, the results suggest that *Rattus* plays a role as reservoir host for vector-borne bacteria and that there is relationship between the period of infectivity and transmission to the ectoparasitic vector.

Transmission dynamics and mathematical modelling of Bartonella in invasive rats

Bartonellosis encompasses a broad range of diseases and clinical symptoms caused by bacteria of the species-rich genus *Bartonella*. Three discrete species have been identified in rats from South Africa, of which one, *Bartonella elizabethae* has known zoonotic potential. Brettschneider *et al.* (2012b. *Vet Microbiol* 157, 132-136) developed a model to study the dynamics of *Bartonella* transmission related to host and ectoparasite vector aspects. However, the model was based on limited data for a number of crucial biological parameters and did not adequately explain the differential infection rates observed. The present study attempted to refine the Brettschneider *et al.* (2012b) model by obtaining empirical estimates for biological parameters based on general rodent data, rather than *Rattus*-specific data. This is being achieved by a combination of molecular data and mathematical modelling approaches, the results of which will negate estimation of crucial biological parameters. Ms Asiashu Lithole's study aimed to investigate: vertical transmission of *Bartonella* in *Rattus* from South Africa using molecular techniques; the prevalence of *Bartonella* in ectoparasites using molecular techniques; and d) use improved parameters resulting from this study to predict the dynamics of *Bartonella* infections in *Rattus* using a revised version of the mathematical epidemiological model described above.

Thirty-five of 82 *Rattus* females sampled were pregnant. All pregnant rats were then screened for *Bartonella* using the three primer sets and we found an average infection prevalence of 54%. Embryos from these pregnant females were also screened for *Bartonella*. This represents an average infection rate of 61%, confirming that vertical transmission occurs in members of this invasive genus. This is very valuable empirical data for an important model parameter and can be used to inform pest management strategies.

Abundance, occupancy and aggregation

Predicting changes in abundance is pivotal for evaluating the conservation status and population viability of invasive and threatened species and is one area where work on invasive species can feed into broader issues in ecology. Empirical work has suggested that species whose abundance is increasing have more aggregated distributions than those with declining abundance (known as the change-aggregation hypothesis).

C·I·B core team member Cang Hui and colleagues designed an improved negative binomial distribution model of the occupancy-abundance relationship to estimate changes in abundance from changes in occupancy or aggregation (Hui *et al.* 2012. *Basic Appl Ecol* 13, 169-177). The model suggests that in general, the change in abundance is synchronized with the change in occupancy when the level of environmental heterogeneity remains constant. Further, a threshold of the population density could exist above which the change-aggregation hypothesis is no longer valid. Tests using data of epigaeic ants in fynbos collected from different seasons and macro-invertebrates from different localities in streams of central Spain verified these model propositions and indicate that the model can be used to assess species persistence. Results from the modelling exercise also suggest that changes in abundance can be estimated from cost-efficient presence-absence records (occupancy data). A revision of the traditional change-aggregation hypothesis is necessary to capture the threshold phenomenon in the change-aggregation relationship.

This work sheds light on the mechanisms behind the two-phase range expansion of many invasive species. For instance, the existence of the change-aggregation hypothesis threshold could reflect a percolation process of species distribution where the aggregated structure strengthens with the increase of population size but slowly declines once the population size passes beyond the percolation threshold. The existence of this threshold thus implies a two-phase increase of occupancy, as in the range expansion of many invasive species: from an initially low spreading rate to a high rate after a lag phase. The sudden change in spread rate could happen when the population size reaches the percolation threshold, consistent with the revised change-aggregation hypothesis presented in this paper.

Raunkiær's law of frequency reaffirmed

In 1934, the Danish botanist Christen C. Raunkiær presented his law of frequency, portraying a bimodal occupancy-frequency distribution (OFD) in plant communities. This law suggests that species in a community are either rare or common, with only few species having intermediate occupancies. Specifically, when the occupancy is divided into five classes (0-20%, 21-40%, 41-60%, 61-80% and 81-100%), the first and last classes contain the most records, with the leas records in the 61-80% class. Although many different OFD patterns occur, this bimodality is still common (27% of the 48 matrices reviewed by McGeoch & Gaston 2002. *Biol Rev* **77**, 311-331). Three explanations of the bimodality of OFDs include (i) that they are artefacts of sampling highly-skewed relative abundance distributions (Papp & Izsák 1997 *Oikos* **79**, 191-194); (ii) the core-satellite hypothesis that if local extinction is subject to a strong rescue effect in a meta-community, the balance of colonization by new species and the extinction of existing species will lead to a bimodal OFD (Hanski 1982 *Oikos* 38, 210-221); (iii) that bimodality could be a transient pattern due to the effect of spatial scales on species occupancy (Hui & McGeoch 2007. *Oikos* 116, 2097-2107).

Using a representative dataset of 289 species-by-site matrices, C·I·B researcher Cang Hui presented the mathematical relationship between rank curves of species occupancy and OFDs, reaffirmed the estimate of about 24% bimodality in OFDs, and identified the truncated power law as the dominant form of occupancy rank curves. This paper outlined the use of occupancy-based null models in identifying underlying ecological processes in communities. The results suggest that the form of the OFD could be a signal of community functions and structures - for example, work currently underway includes investigating whether we can use OFD forms as an indicator of community invasibility. Specifically, when compared with a right-skewed unimodal OFD, a bimodal OFD could signify a more deterministic-process-driven community that has a low invasibility (Hui 2012. *Community Ecol* 13, 30-35).

The macroecology of a model genus for plant invasion ecology under the spotlight

The genus *Pinus* (pines) has emerged as a major model group for the elucidation of many fundamental issues in plant invasion ecology, and invasion science in general. C·I·B Director Dave Richardson and long-term collaborator Marcel Rejmanek of the University of California have been working on the invasion ecology of pine trees for many years. Teaming up with former C·I·B post-doctoral associate erban Proche at University of KwaZulu-Natal and C·I·B core team member John Wilson from the South African National Biodiversity Institute (SANBI), they have now investigated the global distributions of pine tree species, relating the size of invasive ranges to indigenous ranges and a whole range of other intrinsic and extrinsic characteristics (Proche *et al.* 2012. *Global Ecol Biogeogr* 21, 513-523).

The authors were at first surprised to discover that the relationship between indigenous and invasive ranges was very weak. Species with very small indigenous ranges like *P. patula*, *P. elliottii*, and *P. radiata* have attained remarkably large ranges in the regions they have invaded, whereas some of the species that are naturally most widespread, like *P. sibirica* and *P. pumila*, have not become naturalised elsewhere (Fig. 3). Incorporating the other variables, the authors showed that this weak relationship can be explained by the fact that intrinsic attributes such as trees' reproductive strategies only explain part of their success as invaders. A much greater part has to do with how widely trees have been planted by humans. Therefore, even intrinsically poorly-prepared species can readily become invasive with repeated, successive and concerted introduction efforts. This is a rather disturbing thought, considering how many plant species are being introduced repeatedly to climatically-suitable regions, whether intentionally or accidentally.



Fig. 3. The Proche *et al.* (2012) study on the macroecology of conifer invasions was featured on the cover of the May 2012 issue of *Global Ecology and Biogeography*. This cover image shows *Pinus radiata* invading fynbos in the Langeberg Mountains of the Western Cape (Photo © Dave Richardson).

Can the colours or shapes of invasive plants tell us how they interact with native plants?

Research on invasive species has the potential to shed light on many fundamental aspects of the functioning of ecosystems, for example the role of pollinators. It is well known that invasive plants compete with native plants for resources such as light and water, but competition for pollinator visits is often overlooked. By drawing pollinators away from native plants, invasive plants may reduce seed production in native plants, and invasive plants with similar looking flowers to native species can be expected to attract the same pollinators, be they birds or butterflies. C·I·B MSc student Michelle Gibson explored whether native plants with flowers that are similar to those of invasive species are more likely to suffer the effects of this type of competition. Her work used the widespread invasive plant impacts on native flowering plant communities (Gibson *et al.* 2012. *J Ecol* 100, 1216-1223), and was the first to show that floral characteristics could indeed be used to investigate how co-flowering plants interact with one another via shared pollinators (Fig. 1).



Fig. 1. Invasive stands of *Acacia* saligna often make use of native insects such as beetles for pollination services in South Africa (photo © Michelle Gibson).

Two beetles, two tales of temperature influence

Understanding the responses of organisms to climatic changes requires a sound knowledge of the temperature sensitivity of performance, organismal phenotypic plasticity and the time course of temperature exposures. C·I·B Ph.D. student Jessica Allen has been exploring these questions using several model organisms: beetles and springtails. Jessica showed that two beetle species, *Tenebrio molitor* and *Crytobagous salviniae* have distinct tolerance responses to increasing temperatures when exposed to different rates of temperature change (Allen *et al.* 2012. *J Insect Physiol* 58, 669-678). *Tenebrio molitor* had a reduced tolerance (for both minimum and maximum tolerated temperature) at high rates of temperature change whereas in *C. salviniae*, the opposite effect was found, suggesting that generalisations cannot easily be made about species responses to climate change. Both species had low acclimation ability, indicating that they have limited ability to change their critical limits at short time scales. These findings are particularly relevant for assessing the ability of *C. salviniae* to control the spread of the highly invasive Kariba weed (*Salvinia molesta*) while withstanding climatic changes (Fig. 2).



Fig. 2. Adult *Cyrtobagous* salviniae on Kariba weed (photo © Katherine Parys).

MOLECULAR METHODS AS TOOLS IN INVASION SCIENCE Bird invasions under the spotlight using molecular tools

Geographic range expansions have presented a number of puzzles for scientists. The first of these is known as Reid's paradox which recognises that species ranges often expand much faster than would be expected from observed dispersal rates. This paradox was solved in theory by showing that the rate of dispersal of individual animals and plants increases towards the front of an expanding range edge.

The paper by Berthouly-Salazar *et al.* (2012. *Conservation Genetics Resources* 4, 621-624) looked at a range of morphological characters in birds sampled from across their South African range and correlated variation in these traits with distance from introduction point. Morphological variation in dispersal-related traits in females was significantly correlated with distance from Johannesburg, indicating that females may be the dominant dispersing sex. It also suggests some selection for stronger dispersers at the front of the colonization wave. In contrast, non-dispersal related traits were correlated with local environmental conditions rather than distance from the introduction site, indicating possible adaptation to local conditions.

The second puzzle is how genetic diversity is maintained across an expanding range. Standard models of dispersal as a pure diffusion process predict the erosion of genetic diversity at the expanding range margin, which is obviously disadvantageous. However, recent models including fat-tailed dispersal kernels (i.e. modelling dispersal with many short-distance and few long-distance dispersal events) show a radically different result: instead of genetic erosion, a combination of short and long distance dispersal could actually result in an increase in genetic diversity at the expanding range front. However, this effect remains to be demonstrated in nature.

ACACIAS AS MODEL SYSTEMS FOR UNDERSTANDING INVASIONS AND IMPACTS Port Jackson willow's global travels unravelled

Understanding the processes that shape species distributions and their evolutionary trajectories has long interested biogeographers, ecologists and phylogeographers. There is growing interest in better understanding processes that underpin the evolutionary trajectories of contemporary species movements, especially those that have become invasive. Historical and contemporary biogeographies are both important, with the former influencing the latter in several ways.

Biological invasions are typically characterized by stochasticity, founder events and strong genetic drift, and introduced genotypes usually encompass only a small proportion of the total genetic diversity of the taxon. It is therefore important to understand the structure of natal populations when building a framework for testing hypotheses about the processes driving biological invasions, such as introduction histories, hybridization, gene diversity, and ultimately, evolutionary potential Thompson *et al.* (2012. *Mol Ecol* 21, 3187-3199) studied the population genetic structure of the invasive tree *Acacia saligna* and found that, despite high native range genetic structure in native Australia, the invasive South African populations are genetically novel compared to the native lineages present in Western Australia. Surprisingly, this genetic novelty is unparalleled in other introduced populations sampled in Israel, Italy, Portugal, Spain and the USA, and may be the cause of the successful invasion of the species in South Africa.

The genetic novelty of South African populations is thought to be due to the long history of cultivation of *A. saligna* in its native range, and the manner and scale at which the species was introduced and planted in South Africa. These processes obviously have important bearings on traits associated with successful invasions. Harris *et al.* (2012. *Evol Ecol* 26, 1345-1360) set out to test whether there was any correlation between growth traits, introductions histories and levels of genetic bottlenecks between native and invasive populations of Australian acacias. This research showed that no consistent correlation exists between growth performance and levels of standing genetic diversity, in particular that a reduction in genetic diversity is not necessarily associated with a reduced capacity for adaptive responses or invasion potential.

Mechanistic understanding of Acacia invasion in riparian zones

Riparian ecosystems of the south-western Cape are potentially vulnerable to stream flow reductions due to the concomitant pressures of climate change and increased demand for water associated with human demographic trends in the region. Woody invasive alien plants that dominate riparian zones aggravate this situation. Managers of control initiatives often experience a lack of information on the species- and site-specific ecological properties that may help to prioritise sites and optimise eradication initiatives. To address an aspect of this challenge, MSc student Caspar Crous wanted to gain a mechanistic understanding of how woody species, especially invasive species, adapt their hydraulic strategy across this proxy for water availability. Crous et al. (2012a. Biol Invasions 14, 619-631; and 2012b. Trees 26, 1527-1536) determined whether woody plants portray different physiological (vulnerability to cavitation) and wood anatomical traits (wood density, vessel resistance to implosion, vessel lumen and wall diameters) across three prominent riparian zones that differ in stream flow quantity. When compared physiologically to native trees, the invasive Acacia mearnsii was consistently more drought-tolerant, suggesting that it is likely to persist under drier conditions in the future. This woody legume is also highly plastic in its anatomical traits in relation to variable water availability, indicating an ability to persist under a range of environmental conditions. It therefore remains a top priority for control. The native *Brabejum stellatifolium* had consistently higher water potentials across all sites than the other studied species, and is therefore seen as a potentially valuable species for restoration of south-western Cape riparian zones. Species-specific hydraulic responses to different levels of water availability strengthen the argument that it is possible to distinguish site-level drought-tolerance between trees, with great application in understanding future geographic distribution under climate change, and potential for use in restoration research.

A parallel study (Pratt *et al.* 2012. *Int J Plant Sci* 173, 474-483) shed light on the water stressresistance patterns of fynbos species. Life-history types differed in their tolerance to water stress, providing evidence that physiological/functional traits can indeed be linked to functional traits. This is an important finding that enables us to link lower scales of organization (organismal) to higher levels (population, community) in this species-rich biome, thus paving the way for modelling approaches that attempt to understand how drivers of change may impact this biodiversity rich shrubland.

Banking on seeds: long-lived seed banks enable invasive Australian acacias to survive in time and space

Viable seeds of Australian acacias remain in the soil long after the parent plants have died or have been removed. These seed banks enable stands of Australian acacias to re-establish, which makes their permanent removal extremely difficult and means that managers have to repeatedly visit cleared sites to remove seedlings that have germinated from the seed bank. This leads to lower costeffectiveness of clearing operations. Despite the significance of Australian acacias in South Africa and the importance of seed banks in hampering their management, there is a general lack of knowledge on seed bank dynamics. Much of the information on seed bank dynamics has been collected in isolation or has used different sampling methods, making it difficult to generalize to other sites and conditions. Consequently there is a wide gap in our understanding in relation to the seed bank dynamics of Australian acacias in South Africa. This case in relation to a global context is not unique and only a few studies on the seed bank dynamics of alien invasive plants have been completed.

The seed banks of the most prominent ant-dispersed invasive Australian acacia in the Fynbos Biome are currently the focus of C·I·B PhD student Matthys Strydom (working with C·I·B core team members Karen Esler, John Wilson and C·I·B PhD graduate Ruan Veldtman [SANBI]). During the

final year of his BSc, Matthys found that despite biological control agents being present at his study sites for the past 21 years, seed banks were still large, and posed a serious management challenge. This emphasized that a single clearing event is not sufficient for control, and that budgets need to include aspects of managing the seed bank (Strydom *et al.* 2012). For his MSc project, Matthys determined the seed rain and seed bank status of *Acacia saligna* across its distribution in South Africa. By assessing the influence of different abiotic and biotic factors he was able to predict under which conditions the seed banks of this species will be most problematic for control and management (Strydom *et al.*, 2012. *S Afr J Bot* 79, 140-147).

DETECTION, DEMONSTRATION, RESPONSES AND REMEDIATION

Restoration and invasion ecology combine to improve invasive species management

Researchers and practitioners in the disciplines of restoration and invasion ecology have much to learn from each other. These synergistic mission-driven disciplines are relatively new and share many similarities and cross-cutting debates. Dealing with invasive species is often a key element of ecosystem restoration to achieve goals other than the removal of the invasive species itself, while restoration is increasingly seen as vital when dealing with the aftermath of invasion control.



9 Investigate outcomes and publish results in scientific and general fora

Fig. 4. Simplified and general framework for restoration of sites after alien invasion including practitioners, restoration ecologists and invasion ecologists. In a first step, practitioners approach restoration and invasion ecologists with a specific need for ecosystem restoration and identified knowledge gaps. Before restoration goals can be identified, invasion ecologists need to determine the degree of ecosystem degradation (step 2). In a subsequent workshop (step 3) both ecologists and practitioners will have to decide on restoration goals which are ecologically and economically feasible. Depending on the situation, other parties (for example, conservation organizations) will have to get involved (step 3). Once restoration aims have been identified, restoration ecologists will have to identify research questions to enhance knowledge gaps whereas invasion ecologists will look at the broader ecosystem context (step 4). In a joined effort, restoration ecologists and practitioners can then develop restoration and invasion ecologists can collect data to monitor restoration success and investigate species interactions and disturbances. Findings can then be communicated to practitioners, who can modify and adapt restoration accordingly. The iterative feedback of research results into practice can guarantee ongoing monitoring and improvement of practice (steps 6-8). Finally yet importantly, restoration and invasion ecologists can investigate restoration outcomes and publish the results to make the findings available to the scientific community (step 9).

C·I·B researcher Mirijam Gaertner and co-authors reviewed the literature to combine insights from restoration and invasion ecology to enable more effective management of invasive species while simultaneously informing restoration practice. The reviewed literature included 1075 articles from 62 countries. The authors analysed the articles for the type of restoration applied, determined by the aim of the study, and conducted further content analyses on 208 selected studies that showed a link to biological invasions (Gaertner *et al.* 2012. *NeoBiota* 12, 57-76). Approximately 200 of the papers reviewed indicated an invasion - restoration link. Restoration activities mostly focused on controlling invasion, largely neglecting other underlying causes of degradation such as human disturbance. Furthermore, the authors established that the current practical approaches for dealing with alien invasions in a restoration context are not informed by theoretical knowledge. The authors suggest that closer collaboration between invasion and restoration ecologists can help to improve the management of alien plant invasions. To achieve this closer collaboration, a framework was developed which integrates the two disciplines with the aim of informing restoration practice (Fig. 4).

Towards objective options for restoration following clearing of invasive plants

Researchers at the C·I·B contributed to a new academic textbook that describes recent advances in restoration science and in the practice of ecological restoration, covering ecosystems and biomes from around the globe. The book, edited by Jelte van Andel and James Aronson, is entitled 'Restoration Ecology: The New Frontier', and is aimed at restoration researchers and practitioners (Fig. 5).

C·I·B Director David Richardson and researcher Mirijam Gaertner joined forces with Patricia Holmes from the Environmental Resource Management Department, City of Cape Town, to contribute a chapter that deals with biological invasions and how they relate to restoration science and ecological restoration. The chapter focuses on biological invasions that have undeniably negative impacts on ecosystems, and exclusively on impacts of invasive plant species. The authors review the many ways in which invasive plants can potentially change ecosystem composition, structure, and functioning and summarize the most important challenges restoration ecologists have to face when dealing with alien invasions.

The authors apply the concepts of ecosystem resilience and ecosystem thresholds in developing a framework for decision-making for ecological restoration, focusing on plant invasions. The implications of these concepts for management and restoration are presented using case studies of *Acacia* and *Pinus* invasions in South African fynbos. The framework addresses questions concerning the feasibility of ecosystem restoration (i.e. will removal of the alien species be sufficient to facilitate autogenic recovery of the ecosystem?) and questions relating to the desirability of ecosystem restoration desirable where the alien species have become integrated into socio-ecological systems and may provide valued ecosystem services?).

The authors conclude that explicit attention must be given to the determinants of resilience and the identification of key thresholds for restoration to be successful. This allows for the level of degradation to be quantified, and paves the way for an objective consideration of potential trajectories under a range of management interventions. Further work will be to bridge the gap between understanding the full array of impacts resulting from invasions and knowing how this understanding can be used to formulate restoration plans.



Fig. 5. Work on restoration ecology at the C·I·B has gained much international recognition. Besides contributing a chapter on restoration options in the management of biological invasions, the C·I·B also contributed images for the cover of a new text book on 'Restoration Ecology – The New Frontier'. The images show a section of the Wemmershoek River near Franschhoek in 1985 when the river was fringed with dense stands of *A. longifolia* and *A. mearnsii* (top), and the same section in 2011, following removal of the invasive trees.

Organism-environment feedback is important for habitat restoration

Habitat destruction and fragmentation are primary causes of biodiversity loss, yet many organisms affect their environments on various temporal and spatial scales. The modification and creation of the environment by organisms could potentially facilitate habitat restoration. For example, dune plants can reinforce and stabilize their habitat on drift sand; desert plants can accumulate soil particles and plant debris around them and facilitate their future recruitment. These organism-environment feedbacks can cause complex spatial patterns of species distributions to emerge and lead to surprising results in habitat restoration.

Following Levins' patch occupancy model, C·I·B researchers and colleagues presented a differential equation model incorporating habitat restoration induced by organisms themselves (internal restoration) and by other organisms or/and abiotic causes (external restoration). Stability analysis revealed the existence of alternative equilibriums (i.e., bi-stability) in the system. This bi-stability or threshold phenomenon could arise from density-dependent negative growth rates at low metapopulation size, indicating that a minimum amount of suitable habitat is required for metapopulation persistence. The internal restoration of habitat was identified as the trigger for the bi-stability, whereas the external restoration, in contrast, can eliminate the bi-stability from the system (Zhang *et al.* 2012. *Math Biosci* 240, 260-266).

New developments in river restoration – the Rondegat example

The Rondegat rehabilitation project is a good example of how alien fish invasions can be managed in South Africa. As is the case in some other South African rivers, the only impact on native fishes in the Rondegat River is the presence of invasive alien fish. By eradicating the alien fish, it is often possible to rehabilitate several kilometres of river, with very significant benefits for endangered fish and associated aquatic biota. This strategy is regarded by South African fish conservation experts as the best and fastest way of improving the conservation status of the highly threatened fishes. After a full EIA process, CapeNature treated a four kilometre stretch of the river using the piscicide Rotenone in

February 2012. C·I·B core team member Olaf Weyl and his team have been monitoring the impact of this treatment and recovery of the river ecosystem. Part of this project is being implemented by C·I·B post-doctoral associate Darragh Woodford and PhD student Terrence Bellingan.

GLOBAL ENVIRONMENTAL CHANGE AND ECOSYSTEM SERVICES

National-scale control efforts under the magnifying glass

C-I-B core team member Brian van Wilgen (CSIR) and co-workers gave considerable attention in 2012 to assessing the effectiveness of invasive alien plant control operations by Working for Water. This was done both at a national scale (van Wilgen et al., 2012. Biol Conserv 148, 28-38), and at the scale of smaller catchments (McConnachie et al., 2012. Biol Conserv 155, 128-135). The assessments used new estimates of the distribution of invasive alien plants by the Agricultural Research Council, and records of clearing operations to assess progress. It emerged that clearing is only reaching a small proportion of the estimated invaded area, and that many invasive alien plant species have continued to spread. There have been some successes with biological control, but it has become clear that changes to the general approach to mechanical control will be needed if progress is to be made. One of the recommendations from this work is that control should focus on priority areas. Arguably, there are too many projects in too many areas trying to control too many species. This leads to the dilution of funding and human capacity, with the inevitable consequence that few projects make adequate progress. The magnitude of the problem threatens to overwhelm those tasked with addressing it, and there is a real danger that overall effectiveness will decline if attempts are made to address everything. The question of whether to increase effectiveness by focussing on priority areas, or to continue to operate broadly while at the same time increasing effectiveness (for example by better enforcement of legislation, and tapping additional sources of funding), will be an on-going debate for some time. To support this process, models were developed to prioritize alien plant control projects (Forsyth et al., 2012. J Environ Manage 103, 51-57), and these are starting to inform the allocation of funding.

HUMAN DIMENSIONS

Oyster farming as a focus of marine invasions in South Africa

An important priority for invasion science worldwide is to understand how various human enterprises shape pathways for invasion and how these can be managed to reduce problems of invasive species associated with these enterprises.

In South Africa oysters are grown from spat imported from Namibia, Chile, France and the United Kingdom. These tiny oysters are normally imported to nursery farms that grow them to a larger size before they are sold to other oyster farms along our coast. This movement of oysters between farms and across biogeographic boundaries has raised concerns as oysters are well known as a vector for alien species. The honours project of current PhD student Tanya Haupt was to document the diversity and density of fouling organisms that grow on the oysters, and consider how effective spraying with seawater (i.e. the conventional cleaning method used by farmers), soaking in freshwater and soaking in heated seawater were at removing associated biota. In addition, the survival of alien species following transport to new farms was also considered (Fig. 6).

Nine alien marine species were recorded on oysters, of which only four were removed by conventional cleaning methods while the remaining five species also survived transportation between farms. This demonstrates the risk that certain oyster farming practices pose to biosecurity. Soaking oysters in heated seawater was found to be more effective at removing biota than soaking in freshwater but some organisms survived both treatments. It is thus suggested that inspecting oysters

before they are transferred to a new farm, and public awareness could address the risk posed by translocation of oysters (Haupt *et al.*, 2012. *Afr J Mar Sci* 34, 187-194).



Fig. 6. Ineffectively-cleaned oysters are a vector for invasive marine aliens (photo © Tammy Robinson).

Developing policy on the relocation of threatened species

The C·I·B's core business is biological invasions, but the management of invasive species cannot be considered in isolation from other pressing environmental issues such as global climate change and issues relating to the management of threatened species. 'Managed relocation', also known as 'assisted migration' or 'assisted colonization', is a controversial conservation strategy that involves the deliberate movement of species into new habitats to improve their chances of long-term survival. Dave Richardson has been working as part of an interdisciplinary group of scientists, researchers, and policymakers (the Managed Relocation Working Group) to examine the conditions that might justify the use of managed relocation and to assess the research being conducted on the topic.

In a paper in BioScience, Schwartz *et al.* (2012. *Bioscience* 62, 723-743) reported that although traditional management strategies are not likely to address the effects of climate change adequately, guidelines and protocols for managed relocation are poorly developed: 'Developing a functional policy framework for managed relocation is a grand challenge for conservation'.

Moving a species to a higher elevation, for instance, may allow it to survive rising temperatures or an elevated sea level, but doing it in an ethically acceptable way is fraught with both legal and political complications. Unforeseen environmental consequences can be severe, for example, the species might become invasive in its new location. Many people question the appropriateness of conserving a single species if it involves possibly disrupting an entire ecosystem. Poor regulation of managed relocation may also open the door to exploitative movement of species. Regulation is often dispersed among provinces, national governments, and various agencies, which may have conflicting agendas, and most relevant policies and laws were not written with climate change in mind.

The current state of ecological knowledge is at a level that makes predicting the effects of any particular proposed relocation very difficult, and this is likely to remain the case for the foreseeable future. This makes it hard to know which species are most likely to benefit from managed relocation. Even so, *ad hoc* managed relocation projects are already under way in the United States and the United Kingdom.

The authors recommend action by government agencies to develop and adopt best practices for managed relocation. They urge a transparent approach, with integrated research and international involvement of scientists, policymakers, resource managers, and other stakeholders. What is needed, the authors argue, is more research to make better predictions; clearly written policies to define the responsibilities of various parties, to enable management and to limit abuse; and stakeholder involvement to minimise social conflict.

New insights on risks associated with key stages in biological invasions

The human-mediated movement of species around the world has added several layers of complexity to the management of ecosystems. Once alien species are established in a new region, they are extremely difficult or impossible to eradicate, and control is expensive and often ineffective. For this reason, more attention is being given to developing robust ways of preventing the introduction and dissemination of species that could become invasive.

Much research is focussing on developing risk assessment protocols that identify species that pose a high risk of becoming established, spreading and having negative impacts. Formal risk analysis for invasive species aims to provide systematic and comprehensive methodologies for evaluating risks and uncertainties associated with the introduction/spread of organisms, based on the magnitude of possible adverse consequences and the likelihood of occurrence of these consequences. In many countries, legislation relating to invasive species calls for the implementation of formal risk assessment tools to reduce further invasions.

The European Science Foundation (ESF) and the Agency for Management of University and Research Grants (AGAUR) of the Government of Catalonia jointly funded a workshop on methods and applications of risk assessment analysis in managing biological invasions. The workshop was hosted at the University of Girona in Spain during April 2011. The meeting, chaired by former C·I·B post-doctoral associate Núria Roura-Pascual, now at the University of Girona, brought together 21 researchers from around the world with expertise in various aspects of invasion ecology and with an interest in contributing to the development of a more robust framework for and standard protocols for effective risk assessment. The C·I·B was represented by Dave Richardson.

A sub-group of workshop participants lead by Brian Leung (McGill University, Montreal, Canada) was tasked with producing a rigorous conceptual risk assessment framework by reviewing more than 300 published risk assessment studies. The paper, published in the journal *Ecology Letters*, defined risk in relation to each of the major stages in the invasion process: Transport, Establishment, Abundance, Spread, and also with regard to Impact — the TEASI framework. TEASI components, subcomponents, dependencies, and relationships among these elements are discussed, and combined mathematically into a quantitative RA structure (Leung *et al.*, 2012 *Ecol Lett* 15, 1475-1493).

By mapping each risk assessment in the conceptual TEASI framework, the authors illustrate that the qualitative or semi-quantitative scoring methods are special cases of quantitative models. This framework thus provides the skeleton structure and serves as a starting point for advances in risk

modelling. Importantly, the aim in promoting such an integrative approach was not to suggest that all elements need to be estimated to yield a useful risk assessment, but rather to identify opportunities for improvement, by explicitly demonstrating how different processes in invasion are linked. Most implementations of risk analysis do not cover all elements of the invasion process, and the new framework provides guidance on which elements should be included in risk assessments and how they should be combined.

Some suggestions for future improvements on risk analyses for invasive species management are:

- Research should explicitly demonstrate when such quantitative approaches yield benefits over qualitative ones. There have been substantial advances in quantitative approaches, but they have often not been applied in policy (in contrast to scoring approaches);
- The development of synthetic models which are generalizable across a number of species, environments and the invasion process could allow these quantitative approaches to be broadly applied for policy purposes;
- In terms of uncertainties, for both quantitative and scoring approaches, it may be useful to identify generalities of which uncertainties are important to include in different circumstances. Rules for exclusion of subcomponents that do not improve predictive power should be derived.

Beneficiaries' aspirations to permanent employment within the Working for Water Programme

Research by Anton Hough and Heidi Prozesky (2012. Soc Dynamics 38, 331-349) explored beneficiary dependence on four different Working for Water (WfW) projects under the auspices of CapeNature, in the Winelands and Overberg districts of the Western Cape. It involved analysing data, collected through face-to-face interviews, about the aspirations of WfW beneficiaries regarding permanent employment. The positive social impact of WfW's programme was evident in that four WfW projects surveyed did provide a social security net for their beneficiaries. However, the research casts doubt on these projects' ability to stimulate economic growth through entrepreneurship, as the data reveal that beneficiaries have a high degree of financial dependence on, and unrealistic expectations of, the WfW Programme. A significant finding was that the social structures within projects themselves seem to create a need to remain in the WfW programme. In particular, the relatively safe and enjoyable work environment facilitated by WfW's Contractor Development Approach and teamwork approaches may contribute to beneficiaries becoming financially dependent on WfW, by inhibiting their engagement in alternative employment. In addition, a misalignment between project implementation and beneficiaries' aspirations to financial stability (associated with permanent employment in WfW) is highlighted by the study. Based on these findings, it is recommended that WfW should respond to beneficiaries' aspirations, rather than pursue the ostensibly unrealistic aim of creating independent entrepreneurs.

Bibliometrics as a tool for measuring gender-specific research performance

Considering the central role that research performance and its measurement plays in assessing and rewarding the performance of scientists, it may be argued that one cannot address the issue of women's participation in science without taking into account gender variations in research performance. In this meta-scientific study, South African invasion ecologists themselves are the subjects of study, with a focus on their gender and research performance. Research by Heidi Prozesky and Nelius Boshoff (2012. *Scientometrics* 90, 383-406) illustrates the difficulties inherent in measuring the quality aspect of sex-specific research performance by means of an analysis of a dataset of articles (each with at least one South African author address) that were published between 1990

and 2002 in the field of invasion ecology in journals included in the Thomson Reuters Web of Science. The research therefore provides evidence that the use of citation counts to compare men and women in terms of the qualitative dimension of their research performance requires meeting a number of methodological challenges, which have thus far been neglected in the majority of studies that draw such a comparison.

Descriptions of gender differences in citations should therefore be approached cautiously, and with particular sensitivity to the effect that gender differences in the tendency to co-author internationally may have on citation counts, as the results indicate that foreign co-authorship is a better correlate of citations than the sex of South African authors. This is true irrespective of whether the annual citation rate or a window period is used, whether or not self-citations are excluded, and whether or not the number of authors is controlled for by calculating fractional counts. By controlling for these variables, the research clearly shows that that the higher number of citations achieved by internationally co-authored papers is not because of a greater probability of self-citing (which, in turn, is possible because of a larger number of authors generally associated with international co-authorship), but because of a genuine 'impact-strengthening' effect of international collaboration.

2 Education and training

2.1 Objectives

The provision of skilled human resources for the South African National System of Innovation forms a central component of the business of the C·I·B. Indeed, the large majority of the research undertaken by the Centre takes place via student training at the post-graduate level. Recognising the enduring 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 will continue to support 3^{rd} and 4^{th} year students who meet either (and increasingly both) of these requirements. The main idea is to draw students 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.

2.2 Progress

2.2.1 Graduations

In 2012, 92 students registered with the C·I·B, of whom 51 were women. Seventeen Honours students; 34 Masters students; 36 PhDs and ten post-docs pursued research projects at the C·I·B; 76 of whom were South African while 19 were foreign. 54 of our registrants were black; 43 were white. In line with our commitment to inter-disciplinarity, two of these registrants pursued social science studies.

Thirty-two students completed their studies in 2012 (17 men and 15 women), including students who registered in previous years. The completions were at the following levels: ten Honours; seven Masters; 11 PhDs and four post-docs. Nineteen of the graduates were black students, twelve of whom are South African.

2.2.2 Employment

C·I·B graduates performed extremely well in the employment market, and 17 graduates and post-docs were employed locally and internationally during 2012 (see Section 7.5 for details).

2.2.3 Awards

The C•I•B student awards for 2012 were presented at the Annual Research Meeting to Marinel Janse van Rensburg (MSc) and Palesa Natasha Mothapo (PhD) for outstanding posters on their work. The

posters were judged by the science advisors and guest speaker, Prof. Richard Duncan, Prof. Anne Magurran and Dr Piero Genovesi.

MSc student Rolanda Julius was awarded a travel grant to attend the International Conference on Vertebrate Pests in Monterey, California. Rolanda presented her work on the mechanisms and impacts of invasive rats in South Africa, and the paper will be published in the Proceedings of the 25th Vertebrate Pest Conference (in press).

2.2.4 Science communication

For the second year running, Stellenbosch University's Post Graduate Skills Development Programme organised the New Voices in Science workshops and competition, aiming to teach PhD students to communicate their research so that 'your mother can understand it', as coordinator Ronel Steyn describes it. Two workshops were hosted by Stellenbosch University and presented by well-known science journalist and editor George Claassen and author and former C·I·B associate Leonie Joubert. The workshops focused on presentation skills, sound bites and the art of describing your research in a concise yet exciting manner, as well as writing about the impact of research so that it is understood by both journalists and diverse audiences without over-selling, being informative and thought provoking with as little jargon as possible.

The C·I·B was well-represented at the workshops which finally culminated in a prestigious colloquium held at the Stellenbosch Institute for Advance Studies (STIAS) on the 5 December and hosted by Prof. Eugene Cloete, Vice-Rector for Research at Stellenbosch University. Of the 14 PhD students who were selected to present at the gala event, three were C·I·B students.



Fig. 7. Natasha Mothapo (left), Marguerite Blignaut (right, with Prof. Eugene Cloete, Dean of Science, Stellenbosch University) and Bernard Coetzee (not shown) were recognized at the New Voices in Science event for outstanding communication of their Ph.D. projects

Natasha Mothapo was a finalist in the oral category and intrigued the audience with her research on highly invasive Argentine ants and their destructive influence on both our native ants and the Fynbos Biome. Marguerite Blignaut and Bernard Coetzee were both finalists in the popular science article competition, and their articles are published, together with 22 others, in the New Voices in Science 2013 publication (Fig. 7). Marguerite Blignaut walked away with the category prize for her piece entitled 'Secret agents and the survival of aliens', which looks at the role of epigenetics in invasive fountain grass.

3 Information brokerage

3.1 Objectives

One of the central roles of the CI-B is to foster a knowledge economy, and to use the outcomes of its knowledge production to promote a sustainable society. In consequence, information brokerage at a wide variety of levels forms an important part 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 WEB SERVICES

The C·I·B web pages received 17 966 visits from 13 007 unique visitors during 2012. 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 <u>http://academic.sun.ac.za/cib/news.asp</u> for details). Besides generating knowledge and sharing it, the C·I·B has created a knowledge management system to secure and manage long-term research data and outputs. The Information Retrieval and Submission System (IRSS) currently stores more than 600 research papers, 177 theses and data sets, including data sets from graduated students and long-term projects. These resources will gain value over time in facilitating the recognition of long-term patterns and opening opportunities for broader collaborations.

2012 ANNUAL RESEARCH MEETING

The C·I·B was fortunate to have Piero Genovesi (Chair of the Invasive Species Specialist Group, IUCN Species Survival Commission) visit the Centre in November 2012 and deliver a keynote address at the Annual Research Meeting (Fig. 8). The meeting also featured keynote addresses from Richard Duncan (Lincoln University, New Zealand and C·I·B Board member), Anne Magurran (University of St. Andrews, UK and C·I·B Board member), Eugene Cloete (Vice-Rector: Research, SU) and core team members Brian van Wilgen (CSIR), Jaco Le Roux (SU) and Bettine Jansen van Vuuren (UJ). The programme was designed to increase the exposure of our team members (researchers and students) to current science in invasion biology and to promote discussion of the way forward for the Centre's research portfolio. All C·I·B-supported students were invited to the meeting, as were 98 external guests, many of whom attended and contributed to the discussions.

OTHER MEETINGS HOSTED

Two major meetings were arranged by the C·I·B in 2012. The first, in August, was entitled Rapid Response, Early Detection & Risk Assessment of Invasive Species (RREDRA). The workshop presented the opportunity for invited international experts to exploration key themes that are central to advances in the field of risk analysis and management of invasive species. In September 2012, the C·I·B organised a workshop in Patagonia, Argentina, that brought together 21 researchers from around the world to discuss all aspects of alien tree invasions (see section below).



Fig. 8. Dr Piero Genovesi, Chair of the Invasive Species Specialist Group, IUCN Species Survival Commission, speaks at the C·I·B's annual research meeting in November2012.

Tree invasions – Strengthening the C·I·B's international expertise

In the past few decades trees have become among the most widespread and damaging of all invasive species. Invasive trees, including escapees from alien tree plantations, have huge impacts on biodiversity, ecosystem functioning, and human livelihoods in many parts of the world. Despite the increasing attention to trees as invasive species worldwide, problems associated with these invasions are becoming increasingly widespread and complex. Syntheses on patterns and processes of tree invasions are currently based on only a small number of invasive species and invaded regions. Consequently, the roles of some fundamental driving forces are still poorly understood and difficult to generalize. Many introduced tree species are crops of commercial importance in some parts of the landscape, but serious pests in others. This creates complex conflicts of interest which hinder management efforts. With these factors in mind, it was timely to hold a workshop to produce a synthesis, in the form of a journal special issue, which will move discussions on tree invasions beyond the elucidation of case studies.

The workshop was held on Isla Victoria, an island in Nahuel Huapi Lake, a ferry ride from Bariloche. The island, now part of a National Park, was privately owned in the early 20th century during which time deer and wild boar were introduced to the area. In the 1920s the island came under government jurisdiction, and large areas of the island were planted with alien trees to 'improve the area for tourism' and to sustain the local forestry industry. Several of the alien tree species have become naturalised and spread into the native vegetation. Important studies have been conducted on the island to determine, for example: interactions between native and alien mammals and introduced trees; the role of below-ground mutualisms in driving conifer invasions; the role of propagule pressure in driving tree invasions; and seed predation as a barrier to alien conifer invasions. This 'natural tree introduction/invasion laboratory' and the stunning scenery made the island the ideal location for serious deliberations on many aspects of tree invasions.

South Africa is the 'world capital of tree invasions' and has already gained international recognition for research in this field. There is, however, much more work to be done to achieve a general understanding of the wide range of factors involved in mediating the outcome of tree introductions and that shape the options for management. Befitting its status as a global hot-spot of tree invasions, South Africa was well represented at the meeting, with eight participants from the C·I·B: Dave

Richardson (who chaired the workshop), Brian van Wilgen, Mark Robertson, Cang Hui, John Wilson, (all core team members) post-doc Vernon Visser, and students Luke Potgieter and Jason Donaldson.

Other researchers came from across the globe: Estela Rafaele, Maria Andrea Relva and Martín Nuñez (Universidad Nacional del Comahue, Argentina), Brett Bennett (University of Western Sydney, Australia), Bruce Webber (CSIRO, W. Australia), Aníbal Pauchard (Universidad de Concepción, Chile), Annabel Porté (Université Bordeaux, France), Ian Dickie (Landcare Research, New Zealand), Michael Gundale (Swedish University of Agricultural Sciences), Paul Caplat (Lund University, Sweden), Bruce Maxwell (Montana State University, USA), Marcel Rejmanek (UC Davis, USA) and Phil Rundel (UCLA, USA).

The workshop involved presentations and discussions on many topics related to tree invasions, including topics as diverse as the role of fungi in tree invasions, the history of social perceptions of tree introductions, and the development of an inventory of invasive trees worldwide. The main product of the workshop will be a special issue of the journal *Biological Invasions* which will aim to synthesize the current understanding of many facets of invasive trees. The workshop has already led to new collaborations involving the C·I·B on a range of topics.

3.2.2 Scientific communication with students

See 'Scientific communication with peers' above.

3.2.3 Communication with partners

See 'Scientific communication with peers' above.

3.2.4 Communication with the public

In February 2012 the C·I·B received a visit from the Minister of Science and Technology, Ms Naledi Pandor. The Minister showed great interest in Iimbovane and encouraged the project team to continue with their excellent work in making biodiversity science a reality for learners and educators. The Minister's visit also resulted in useful media coverage for the Centre (see Section 8.9).

IIMBOVANE OUTREACH PROJECT

Highlights from 2012 include the visit of the Minister of Science and Technology to the Iimbovane Outreach Project, outreach visits to schools and the newest scientific publication showcasing the data collected by the learners and educators who participated in Iimbovane. Between March 2012 and October 2012, the project team visited 18 Iimbovane schools. The aim of these visits was to give learners a hands-on experience of biodiversity science by involving them in data collection activities in their surrounding school grounds. A new addition to these visits included fieldtrips to nearby nature reserves or national parks for the learners. This addition proved to be valuable, as most of these learners had never before set foot in a protected area. Learners could see the difference between habitats that has been disturbed by human activity and areas that have no signs of disturbance, which improved their understanding of biodiversity and environmental change. Learners from eight schools were able to accompany the project team to protected areas. In August 2012, the team paid another visit to the participating schools with the focus of teaching learners and educators about data capturing, data analysis and how to characterise the biodiversity of an area.

The long winter school holidays were the ideal time to host the annual Iimbovane Biodiversity Winter Week for learners from Sugar Ant subscription schools. The event was hosted from the 24–29 June 2012 on the Stellenbosch University campus and was attended by 21 learners. The main aim of this

learner workshop was to expose learners to the field of biodiversity science as an academic field of research and to give them a taste of student life. Promising learners spent a week at the Iimbovane ant laboratory where they learnt how to use scientific equipment for the identification of invertebrates. The programme was made up of several lectures, interactive activities and field excursions which exposed learners to a variety of ecosystems found in the Western Cape and the biodiversity found in each ecosystem.

Throughout 2012 the project also reached the wider public including learners and educators from several schools which do not formally participate in the project. In April 2012, the project team was involved in the training of educators by providing support to the Institute for Mathematics and Science Teaching, at SU, in the training of life science educators. The outcome was a four-day educator workshop, where the Iimbovane project team facilitated and presented lectures and practical sessions that dealt with biodiversity. The project team continue to strengthen their partnership with the Western Cape Education Department (WCED) by facilitating several training workshops. In August 2012, the project team facilitated a workshop at the WCED's Science Expo for schools from the Overberg District. The workshop was aimed at promoting science as a career among Grade 10, 11 and 12 learners. The project also trained a number of local and international educators by facilitating educator workshops at the Third Annual Cape Winelands Environmental Expo and Youth Conference and as part of the Global Environmental Teachings Programme (Fig. 9).



Fig. 9. Iimbovane team member, Keafon Jumbam, works with an educator to identify ant species during a oneday Global Environmental Teachings Programme educator workshop.

The project further remained relevant as a research venture with the publication of another peer reviewed paper. The paper, which included data that was collected by the project, was published in the scientific journal *PLoS One*. The paper entitled 'The Fynbos and Succulent Karoo Biomes do not have exceptional local ant richness', investigated the species richness of local ant communities in the Fynbos and Succulent Karoo Biomes. It also compared local ant richness to that of similar habitats across the globe and compared regional ant richness with global data (Braschler *et al.*, 2012).

In 2012, the positive impact of the project reached beyond the classroom. For two Grade 11 learners from Diazville High School in Saldanha, Iimbovane was more than just collecting ants. Mischa Carsten and Lee Ann Cloete received a special award at the 2012 International Science Fair with their project on ants (Fig 10). These two learners entered their project called 'Ants, our neighbours' after

their participation in the Iimbovane Outreach Project (Fig. 10). Inspired by their participation in the Iimbovane Outreach Project and a visit to the Iimbovane ant laboratory in 2011, the two learners made ants the focus of their scientific investigation. The learners were awarded by the South African Environmental Observation Network for the best project in the Environmental Studies Category (Senior). In addition to the special award, the learners were also presented with a bronze medal for their efforts.



Fig. 10. Mischa Carsten and Lee Ann Cloete, Grade 11 learners from Diazville High School in Saldanha, with their project 'Ants, our neighbours' at the 2012 International Science Fair

One of the aims of Iimbovane is to encourage learners, especially female learners, to consider biological sciences as a career. Throughout their participation the learners interact with scientists during schools visits and learner workshops. One event where learners are getting a real life experience of life as a student in the biological sciences is during the annual Iimbovane Winter Week. Several learners, who participated in the inaugural Winter Week in 2010 took up degrees in biological sciences at SU in 2013 (see Section 6 and Fig. 11).

Overall, the Iimbovane Outreach Project was hugely successful in reaching out to learners and educators in communities where science, and in particular biodiversity science, is not well understood. Through the hands-on approach of the project of involving educators and learners directly in research, the project has contributed to the challenge of increasing the public understanding and appreciation of biodiversity. The project furthermore contributed to a very informative scientific publication, which is of importance to biodiversity management and conservation.

3.2.5 Media highlights

During 2012, the $C \cdot I \cdot B$'s achievements were well reported in both the local and international media. Although the full list of media interactions can be viewed in the media section of the Annual Report, there is a few highlights that deserve special mention. Highlights from media interactions covered themes including Antarctic science and invasive species.

ANTARCTIC SCIENCE

In March 2012 the C·I·B's involvement in Antarctic research received much media attention after a publication by C·I·B research associate, Steven Chown in *Proceedings of the National Academy of Sciences of the USA*. The paper highlighted the risks associated with the introduction of invasive alien species in the Antarctic region, particularly the accidental introduction of non-native species by tourists and scientists. The paper resulted in articles in the Landbouweekblad, Die Burger and Business Day. A large number of web sites reported on the research, and articles were posted on websites including BBC News, National Geographic, The Economist, Business Day, New Scientist, Fox News and Science Now. The research was further publicised through interviews with Steven Chown on radio stations including Radio Sonder Grense, Cape Talk and Talk Radio 702.

C·I·B research associate, Mr John Cooper, added to the C·I·B's public profile when he was awarded the Lifetime Achievement award from the Pacific Seabird Group as well as the Gill Memorial Medal from BirdLife South Africa for his contribution to seabird research and conservation. This achievement sparked a wide range of media interest with articles published in Die Burger, Weekend Argus, Fishing Industry News and African Birds and Birding.

INVASIVE SPECIES

C·I·B Director, Dave Richardson and C·I·B core team member Brian van Wilgen caused a stir in the media following a review paper about the impacts of invasive pine trees on fynbos areas in *Journal of Environmental Management*. Among other things they suggested that commercial forestry with pines may not be economically or environmentally sustainable in parts of the fynbos biome. The paper led to debates in the media with articles in newspapers and popular science magazines such as Die Burger, Beeld and SA Forestry. In addition to exposure in the print media, the paper also raised discussions in several online articles on websites, including Courier Mail, Business Day, The Green Times and Cape Action for People and the Environment (C A P E) News. Brian van Wilgen was also interviewed on local radio station Radio Sonder Grense.

A current study under the leadership of $C \cdot I \cdot B$ Core team member, Cang Hui and researcher Cécile Berthouly-Salazar was very well received by the media. The study, a citizen science project that looks at the spread of invasive alien birds, called on the public to keep an eye out for invasive alien bird species. The article was published in several district and national newspapers including Vukani, Suid Kaap Forum, Rapport, Cape Argus and Die Burger. In addition to print media, the article also appeared on websites such as African Conservation Fund and IOL Scitech.

The complete list of media interactions appears in Section 8.8.

4 Networking

4.1 Objectives

We achieve scientific progress 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

The CI-B functions as a distributed network (hub-and-spoke model) and much effort goes into ensuring that the network structure functions as smoothly and effectively as possible. Changes during the review period strengthened the CI-B's secondary hub at the University of Pretoria (the Northern Hub), enhanced the range of researchers involved in the Centre as core team members and research associates, and established formal relationships with several important partner organisations. The Centre's core team member and research associate network now includes almost every active university-based researcher in the field of biological invasions in South Africa as well as several noted researchers working in science councils or scientific divisions of conservation authorities. A new model for drawing in research associates was developed in 2012. As a result of this strategy the research associate network has been expanded to include key players in under-represented themes and those associated with existing and potential partner organizations. Because biological control of invasive species in South Africa is funded separately through the Working for Water programme, experts in this area are under-represented in formal associations with the C-I-B. However, good collaborations with researchers working on biological control exist, and these are being strengthened.

In addition to new core team members and research associates, the C·I·B is privileged to work closely with other key institutions and individuals in the field of biological invasions. This enables us to leverage considerable knowledge and experience with local partners such as SANBI, South African National Parks (SANParks), CSIR Natural Resources and the Environment and the South African Institute for Aquatic Biodiversity (SAIAB) and other universities.

A highlight of 2012 was the awarding of a joint research chair (South African Research Chairs Initiative) to the University of Venda and the C·I·B at Stellenbosch University. This initiative will strengthen the C·I·B's activities in the northern regions of South Africa, integrate and support research initiatives that are aligned with the mission of the Centre and provide meaningful support to a historically disadvantaged institution. Through this partnership we are optimizing resources and effort by sharing expertise, personnel, equipment, data and ideas.

During 2012 the renewal of our collaboration with WfW was negotiated for a further five years (2013 to 2018). The second phase of WfW research will focus on Australian eucalypts and acacias, which make up greater than 50% of WfW's projects and consume more than 50% of its budget. With various key stakeholders, the C·I·B has participated in the International Barcoding of Life Project. Projects funded by SAIAB and SANBI have trained post-doctoral associates, students and interns in barcoding field work and laboratory techniques, and contributed to transcribing the DNA of all life on earth.

NEW NATIONAL NETWORKING AGREEMENTS

City of Cape Town

The Environmental Resource Management section at the City of Cape Town has an active initiative called 'Cape Town Early Detection and Rapid Response' (http://www.capetowninvasives.org.za/) through which it works to deal with invasive species. The C·I·B has worked closely with the City on several projects in recent years. In 2012 an MOU was signed with the City to formalize and expand interactions on several fronts. Initially, the City will fund a contract researcher during 2013 (Dr Mirijam Gaertner) to work on the interface between science and practical management, using the City's invasive species problems as test cases. Dr Gaertner will be based at the C·I·B, thereby

providing a strong link with one of our key partners. A major priority for 2013-2014 will be the Blaauwberg Nature Reserve restoration project funded by Kew Gardens (see also Section 5.3.7).

NEW INTERNATIONAL NETWORKING AGREEMENTS

Institute of Botany, Academy of Sciences of the Czech Republic

In 2012, the C·I·B signed a new Memorandum of Understanding with the Institute of Botany, Academy of Sciences of the Czech Republic to enhance supervision and exchange of students and post-doctoral associates, and also co-presentation of courses and workshops on spatial and temporal patterns in animal and plant diversity, including both indigenous and alien species. Prof. Petr Pyšek and his team the Institute are long-term collaborators with several core team members of the C·I·B, and the MOU strengthens these ties. Immediate priorities for collaboration include work on an edited book dealing with plant invasions in protected areas and research on a general theory for the biological basis of invasiveness in plants.

Table 1. Partners, funders and collaborators of the Centre for Invasion Biology. The partnerships in bold type were initiated in 2012.

Partners(hosting one or more core team members)Stellenbosch UniversityUniversity of PretoriaUniversity of VendaUniversity of Cape TownUniversity of JohannesburgUniversity of KwaZulu-NatalCouncil for Scientific and Industrial Research (CSIR)South African Institute for Aquatic Biodiversity (SAIAB)South Africa National Biodiversity Institute (SANBI)South African National Parks (SANParks)

Major funders and donors

Stellenbosch University and the Hope Project Department of Science and Technology National Research Foundation AfriSam Rand Merchant Bank Fund The Drakenstein Trust

Collaborators

Working for Water CapeNature **City of Cape Town Czech Institute of Botany** Iziko Museums of Cape Town Institute for Biological Invasions, University of Tennessee

4.2.2 Academic visitors to core team members

Department of Biological Sciences, University of Swaziland. Collaboration on small mammal ecology with Prof. Ara Monadjem (Chimimba)

- Department of Biology, Norwegian University of Science and Technology, Trondheim, Norway. Collaborator on species distribution and conservation research with Mr Craig Jackson (Robertson)
- Department of Biology of Organisms and Systems, University of Oviedo, Spain. Collaboration on the intra-specific variation of colour, body size and thermal performance of cordylid lizards with Sara Aguado de la Paz (Clusella-Trullas)
- Department of Bioscience, Aarhus University, Denmark. Collaboration on ecology, genetics and physiology of *Stegodyphus* spiders, the: towards obtaining an understanding of the origins and consequences of sociality with Dr Michelle Greve (Clusella-Trullas)
- Department of Environmental Conservation, University of Massachusetts, Amherst, USA. Collaboration on Plant invasion ecology and global change with Prof. Bethany Bradley, (Richardson)
- Department of Environmental Sciences and Studies, Juniata College, Pennsylvania, USA. Collaboration on functional biology and life history evolution of marine and terrestrial crustaceans with Prof. Douglas Glazier (Clusella-Trullas)
- Division of Biology, Kansas State University, USA. Collaboration on Ecology of *Prosopis* invasions in southern Africa with Prof. David C. Hartnett (Richardson)
- Hungarian National Parks; HAKI; University of Kaposvár. Collaboration on developing conservation monitoring of otters in Europe and South Africa with Zoltán Sallai, Dr István Lehoczky, Dr József Lanszki (Somers)
- Institute of Botany, Academy of Sciences of the Czech Republic. Collaboration on Naturalization of introduced plants: Ecological drivers of biogeographic patterns with Prof. Petr Pyšek (Richardson)
- Institute of Ecology & Earth Sciences, University of Tartu, Tartu, Estonia. Collaborator on alien plant distributions across an altitudinal gradient with Dr Jesse Kalwij (Robertson)
- Karlsruher Institut für Technologie (KIT) Campus Süd, Zoologisches Institut Abt. Ökologie/Parasitologie, Germany. Collaboration on invasive fish parasites with Prof. Horst Taraschewski (Weyl)
- Plant Ecology and Nature Conservation, Institute of Biochemistry and Biology, University of Potsdam, Maulbeerallee 2, 14469 Potsdam, Germany. Collaboration on Proteaceae: research and management priorities in a changing world with Mr Jörn Pagel (Esler)
- Plant Ecology and Nature Conservation, Institute of Biochemistry and Biology, University of Potsdam, Maulbeerallee 2, 14469 Potsdam, Germany AND Institut des Sciences de l'Evolution, UMR-CNRS 5554, Université Montpellier II, 34095 Montpellier cedex 05, France. Collaboration on Proteaceae: research and management priorities in a changing world with Dr Frank Schurr (Esler)
- School of Biological Sciences, Medical and Biological Centre, Queen's University Belfast, N. Ireland, UK. Collaboration on functional responses with Prof. Jaimie Dick (Richardson, Weyl)
- Wageningen University, Aquaculture & Fisheries Group, The Netherlands. Collaboration on work on impacts and benefits of alien fish introductions with Dr Leo Nagelkerke (Weyl)

4.2.3 Academic visits by core team members to other institutions

- Australian Wildlife Conservancy. Collaboration with Dr Matt Hayward on Effective Conservation practices project. (Somers)
- CSIRO, Australia. Collaboration on ecological networks with Dr Joe Miller (Hui)
- Monash University, Australia. Collaboration on beta diversity analysis with Prof. Melodie McGeoch (Hui)

- Nangyan University of Technology (NUT) (Singapore). To establish potential research collaborations (Chimimba)
- National Parks 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 – second visit (Somers)
- National University of Singapore (NUS). To establish potential research collaborations (Chimimba)
- Research Coordination Network workshop on Global Invasion Networks, Pontevedra, Spain, September 2012 (Richardson)
- School of Biological Sciences, Medical and Biological Centre, Queen's University Belfast, N. Ireland, UK. Collaboration on functional responses with Prof. Jaimie Dick (Weyl)
- School of Environment and Natural Resources Management, Karatina University College P.O. 1957-10101, Kenya. Collaboration on Innovative Approaches for Balancing Land Use and Nature Conservation on a Trans-National Scale with Gilbert Nduru, Peter Dannenberg, Thomas Göttert & Ulrich Zeller [Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin](Esler)
- Université de La Reunion, UMR CIRAD/ Université de La Reunion, Peuplements Vegetaux et Bioagresseurs en Milieu Tropical, Reunion, France. Collaboration on the ecology of *Casuarina equisetifolia* invasions and the systematics and evolutionary ecology of *Acacia heterophylla* (Le Roux, Richardson, Wilson)

4.2.4 Travel awards to core team members, post-docs and students

- DAAD funding to K.J. Esler & 4 post-graduate students to attend the 2nd international workshop within the 'Quality Network Biodiversity in Sub-Sahara Africa' (funded by DAAD) held at Karatina University College of Moi University (Kenya), October 22-25, 2012 (Esler)
- International Conference on Vertebrate Pests travel award, to attend its conference in Monterey, California, USA (Rolanda Julius; MSc student).

4.2.5 Research collaborations

Adaptive dynamics. Dr Ulf Dieckmann, IIASA, Austria (Hui)

Alien fish parasites. Prof. Horst Taraschewski, Karlsruher Institut für Technologie (KIT) Campus Süd, Zoologisches Institut Abt. Ökologie/Parasitologie, Germany. Collaboration on invasive fish parasites (Weyl)

Ant invasion.s Dr Núria Roura-Pascual, University of Girona, Spain (Hui)

Avian distributions. Dr Lluis Brotons, European Bird Census Council, Spain (Hui)

Avian invasion. Dr Karl Evans, University of Sheffield, UK (Hui)

Avian invasion. Prof. Berndt van Rensburg, University of Queensland, Australia (Hui)

Beta diversity analysis. Prof. Melodie McGeoch, Monash University, Australia (Hui)

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 Technology (CREST), 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 (Esler)
- Biodiversity and human evolution. Collaborator: Prof. Richard Cowling. Department of Botany, Nelson Mandela Metropolitan University (Esler)
- Building a social science platform for Antarctic research. Collaborators: Dr Lize-Marié van der Watt, International Project Office, International Study of Arctic Change (ISAC), Sweden; Prof. Steven Chown, School of Biological Sciences, Monash University; Mr John Cooper; Prof.

Sandra Swart, Department of Sociology and Social Anthropology, Stellenbosch University; and Ms Dora Scott, C·I·B (Prozesky)

- Carnivore Reintroduction Biology and effects on biodiversity, 2004-2012 Collaborators: Micaela Szykman, Humboldt State University; Dave Wildt & Steve Monfort, Smithsonian Institute; Elisa Cameron, University of Tasmania, Kelly Marniwich, Endangered Wildlife Trust; Matt Hayward, Australian Wildlife Conservancy (Somers)
- *Chromolaena odorata* and biodiversity in Hluhluwe-iMfolozi Park, 2011 Collaborator: Kate Parr, Oxford University (Somers)
- Conservation monitoring of otters in Europe and South Africa, 2011-2012. Collaborators: Zoltán Sallai, Hungarian National Parks; Dr István Lehoczky, HAKI; Dr József Lanszki, University of Kaposvár, Prof. Antoinette Kotze and Thabang Madisha, National Zoological Gardens, Kelly Marniwich, Endangered Wildlife Trust.
- Determinants of distribution patterns and spread of plant invasions in protected areas. Collaborators: Prof. Vojt ch Jarošík and Prof. Petr Pyšek, Department of Ecology, Charles University in Prague, Czech Republic, and Institute of Botany, Academy of Sciences of the Czech Republic; Prof. Dave Richardson and Dr Cang Hui, Centre for Invasion Biology, Stellenbosch University (Foxcroft)
- Distribution and conservation biology of wild dog and cheetah. Collaborator: Mr Craig Jackson, Department of Biology, Norwegian University of Science and Technology, Trondheim, Norway (Robertson)
- Distribution and population dynamics of roadside alien plants. Collaborator: Dr Jesse Kalwij, Institute of Ecology & Earth Sciences, University of Tartu, Tartu, Estonia (Robertson)
- Drought response in Fynbos. Collaborator: Dr Anna Jacobsen, Department of Biology, California State University Bakersfield, USA (Esler)
- Ecology of invasive fishes. Prof. Jaimie Dick. School of Biological Sciences, Medical and Biological Centre, Queen's University Belfast, N. Ireland, UK. Collaboration on functional responses (Weyl)
- Effect conservation for single species, 2012-2014. Collaborator: Matt Hayward, Australian wildlife Conservancy (Somers)
- Environmental sustainability. Prof. Dongxia Yue, Lanzhou University, China (Hui)
- Exploring the gap between ecosystem service research and management. Collaborators: Ms Nadia Sitas, PhD student and Prof. Karen Esler, both from the Department of Conservation Ecology and Entomology, Faculty of AgriSciences, Stellenbosch University; and Prof. Belinda Reyers, Natural Resources and the Environment, Council for Scientific and Industrial Research (Prozesky)
- Genetic and morphological variation in two invasive bird species in South Africa. Collaborators: Drs Tim Blackburn, Director of the Institute of Zoology, ZSL, London, Phillip Cassey and Michael Gardner, School of Biological Sciences, Flinders University, Australia; and Dr Cécile Berthouly-Salazar (post doc), Drs Cang Hui and Jaco Le Roux (CIB, SU), Prof. Berndt Janse van Rensburg (C·I·B, UP, now University of Queensland, Australia) (Jansen van Vuuren)
- Genetic status of the African wild cat (*Felis silvestris lybica*) and the potential risk of hybridisation with feral domestic cats (*Felis catus*). Collaborators: Dr Marna Herbst, South African National Parks; Dr Jaco le Roux, Centre for Invasion Biology, Stellenbosch University (Foxcroft)
- Global associations between plant breeding systems and ecology. Collaborator: Mark van Kleunen Institute of Plant Sciences, University of Bern, Switzerland (Johnson)

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

Host-parasitoid interactions. Dr Zihui Zhao, Chinese Academy of Science, China (Hui)

- Impacts and benefits of alien fish introductions. Dr Leo Nagelkerke, Wageningen University, Aquaculture & Fisheries Group, The Netherlands. Collaborator on work on impacts and benefits of alien fish introductions (Weyl)
- Impacts of introduced freshwater fishes on threatened fish species in the Cape Floristic Region. Collaborators Prof. Paul Skelton, SAIAB, Grahamstown; Prof. Jenny Day. Freshwater Research Unit, UCT; Dr Dean Impson, Cape Nature (Griffiths)
- Implication of marine invasions for trophic functioning along the South African west coast. Collaborators: Dr Lynne Shannon, Marine Research Institute, University of Cape Town; Prof. Coleen Maloney, Marine Research Institute, Department of Biological Sciences, University of Cape Town (Robinson)
- Landowner attitudes. Collaborators: Dr Heidi Prozesky (CIB), Dr Guy Preston (WfW) & Ms Lauren Urgenson (Washington State University) (Prozesky, Esler)
- Mechanisms structuring species assemblages in changing landscapes: dung beetles as model organisms. Collaborator: Prof. Berndt van Rensburg, School of Biological Sciences, University of Queensland, Australia (Clusella-Trullas)
- Multi-stakeholder assessment of incentives and barriers to invasive plant management in the Western Cape, a. Collaborators: Dr Lauren Urgenson, School of Environmental and Forest Sciences, University of Washington; and Prof. Karen Esler, Department of Conservation Ecology and Entomology, Faculty of AgriSciences, Stellenbosch University (Prozesky)
- Network analysis. Dr Joe Miller, CSIRO, Australia (Hui)
- Parasites of alien crab *Carcinus maenas*. Collaborator: Claudia Zetlmeis, Universität Karlsruhe, Germany (Griffiths).
- Plasticity of active metabolism and speed of locomotion in insects. Collaborators: Prof. John Terblanche, Department of Entomology and Conservation, and Prof. S.L. Chown, School of Biological Sciences, Monash University, Australia (Clusella-Trullas)
- Post-fire regeneration in Fynbos. Collaborator: Dr Brandon Pratt, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311-1099 (Esler)
- Proteaceae: research and management priorities in a changing world. Collaborator: Dr Frank Shurr. Plant Ecology and Nature Conservation, University of Potsdam, Germany (Esler)
- Rattus in South Africa Collaborators: Prof. Armanda Bastos, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa; Dr Frikkie Kirsten and Dr Emil von Maltitz, Plant Protection Research Institute (PPRI), Agriculture Research Council, Pretoria, South Africa, Dr Helene Brettschneider, National Zoological Gardens, Pretoria (Chimimba)
- Reproductive conflict in mixed race colonies within the hybrid zone. Collaborators: Profs Ben Oldroyd and Madeleine Beekman, School of Biological Sciences, University of Sydney, Australia and Mike Allsopp, Bee Research Unit, Plant Protection Research Institute, Agricultural Research Council (Wossler)
- Responses of lizard communities to global climate change. Collaborators: Dr Krystal Tolley, SANBI (SA), Dr John Measey, Dept. Zoology, NMMU (SA), Bieke Vanhooydonck (University of Antwerp, Dept. of Biology), Anthony Herrel (CNRS, France) (Clusella-Trullas)

- Restoration of natural capital. Collaborator: Prof. James Blignaut. ASSET, Jabenzi, Beatus & Department of Economics, University of Pretoria; Prof. Sue Milton. RENU KAROO, Prince Albert; Dr Dave Le Maitre, CSIR Natural Resources and the Environment (Esler)
- Restoration & monitoring. Collaborator: Dr Belinda Reyers, CSIR, Natural Resources and the Environment, Stellenbosch
- South African and introduced megadriles (i.e. earthworms). Collaborators: Dr Sandi Willows-Munro (UKZN); Dr Danuta Plisko (KZN Museum); and others (Wilson)
- Small carnivores in space and time, 2012-2013. Collaborators: Emmanual do Linh San, University of Fort Hare; Jerry Balant, Mississippi State University, USA; Dr Jun Sato, Fukuyama University, Japan (Somers)

Stream invertebrates. Dr Luz Boyero, CSIC, Spain (Hui)

- Use of scientific evidence in decision-making, the: A case study of the Working for Water Programme. Collaborators: Dr Phumza Ntshotsho and Prof. Belinda Reyers, both CSIR Natural Resources and the Environment; and Prof. Karen Esler, Department of Conservation Ecology and Entomology, Faculty of AgriSciences, Stellenbosch University (Prozesky)
- Water relations in riparian vegetation. Dr Cheryl Swift, Department of Biology, Whittier College, CA, USA (Esler)
- Working for Water beneficiaries' fears of returning to farm work, a case study of. Collaborator: Mr Jan Anton Hough, Coastal and Environmental Services (CES), Grahamstown (Prozesky)

5 Service provision

5.1 International panels and committees

ETH Zurich (Department of Environmental Systems Science), Switzerland (Habilitation dissertation, Invasion ecology) (Richardson)

Executive committee of MEDECOS Association, ISOMED: National Representative (Esler) International Union for the Study of Social Insects: International Advisory Board Member (Wossler) International Association for Biological Oceanography: Executive Member and South African National Representative (Griffiths)

IUCN SSC Invasive Species Specialist Group: Member (Foxcroft, Richardson, van Wilgen)

IUCN Mediterranean-Type Ecosystem Thematic Group: Member (Esler)

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)

Mediterranean Research managers International Cooperative: Member (Esler)

5.2 National panels and committees

(non-NRF only - see below for NRF Service Provision)

Academy of Science of South Africa, National Scholarly Editors Forum: Organising Committee (2011-2012) (Foxcroft)

AfriOceans Conservation Alliance: Board Member (Griffiths)

- Department of Environmental Affairs, Natural Resource Management Programmes: Research Advisory Panel Member (Foxcroft, van Wilgen, Wilson)
- Department of Environmental Affairs, Natural Resource Management Programmes, Working for Water, National Invasive Alien Plant Survey Project: Reference Group Member (Wilson)
- Department of Environmental Affairs and Tourism (provincial): Biodiversity Scientific Working Group Member (Griffiths)

Earth for Elephants working group: Scientific Advisory Board Member (Somers)

Endangered Wildlife Trust - Healthy Rivers Programme: Panel of Experts Member (Weyl)
Fynbos Forum: Committee Member (Esler)

Green Trust. Board of Trustees Member (Chimimba)

Helderberg Nature Reserve: Advisory Board Member (Wossler)

Higher Education Resource Services: Advisory Board Chair (Esler)

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

South African Data Centre for Oceanography. Board Member (Griffiths)

South African Environmental Observation Network Fynbos Node: Liaison Committee Member (Esler)

South African Institute for Aquatic Biodiversity: Advisory Board Member (Griffiths)

- South African National Biodiversity Institute: Advisory Board and Research Committee Member (Chimimba)
- South African National Biodiversity Institute: Bona fide Researchers List Advisory Panel Member (Jansen van Vuuren)

South African National Survey of Arachnida: Steering Committee Member (Chimimba)

Southern African Plant Invaders Atlas: Advisory Board Member (Robertson)

- University of Cape Town, Centre of Excellence at the Percy FitzPatrick Institute of Ornithology: Advisory Board Member (Chimimba)
- University of Pretoria, Faculty of Natural & Agricultural Sciences: Appointments and Promotions Committee Permanent Member (Chimimba)

5.3 Editorial and refereeing activities

5.3.1 Editor

Diversity and Distributions (Editor-in-Chief) (Richardson) *Koedoe* (Foxcroft)

5.3.2 Associate/Assistant Editor

African Entomology (Wossler) African Journal of Aquatic Science (Weyl) African Zoology (Weyl) Austral Ecology (Robertson) Biological Invasions (Hui, Le Roux; Richardson) Diversity and Distributions (Robertson; Wilson) Fire Ecology (van Wilgen) International Journal of Wildland Fire (van Wilgen) Journal of Fish Biology (Weyl) Neobiota (Foxcroft; Richardson) PLoS One (Somers) South African Journal of Wildlife Research (Somers) South African Journal of Science (van Wilgen)

5.3.3 Editorial Boards

African Natural History (Griffiths) African Zoology (Griffiths; Jansen van Vuuren) Animals (Griffiths) AOB Plants (Richardson) Applied Mathematics and Computational Sciences (Hui) Arthropod-plant interactions (Johnson) Environmental Development (Richardson) International Journal of Wildland Fire (van Wilgen) Koedoe (Griffiths; Somers) Navorsinge van die Nasionale Museum, Bloemfontein (Chimimba) Oecologia (Johnson) Smithiana (Griffiths) The Open Zoology Journal (Hui) The Scientific World Journal (Hui)

5.3.4 Reviewing

NATIONAL

African Journal of Marine Science; African Journal of Range and Forage Science; African Zoology; Koedoe; South African Journal of Botany; South African Journal of Science; South African Journal of Wildlife Management; South African Journal of Wildlife Research; Water SA.

INTERNATIONAL

African Journal of Aquatic Science; African Journal of Ecology; American Naturalist; Animal Behaviour; Annals of Botany; Annals of the Missouri Botanical Garden; Aquatic Conservation: Marine and Freshwater Ecosystems; Australian Journal of Entomology; Behavioural Ecology and Sociobiology; Biological Conservation; Biological Invasions; Bioscience; Cahiers de Biologie Marine; Conservation Genetics; Conservation Letters; Diversity and Distributions;Ecology Letters; Ecology & Society; Ecological Economics; Ecosphere; Ecosystems; Environmental Management; Global Ecology and Biogeography; Insect Conservation and Diversity; Insect Science; International Journal of Forestry Research; Journal of Arid Environments; Journal of Applied Ecology; Journal of Biogeography; Journal of Ecology; Journal of Environmental Management; Journal of Great Lakes Research; Journal of Mountain Research; Landscape and Urban Planning; Marine Biology Research; Methods in Ecology and Evolution; Molecular Ecology; Naturwissenschaften; Neobiota; New Phytologist; Norwegian Journal of Geography; Oecologia; Oikos; Physics and Chemistry of the Earth; Plant Ecology; Plant Ecology & Diversity; Plant Species Biology; Plant Systematics and Evolution; PLoS One; Proceedings of the Royal Society of London B; Science; Restoration Ecology; Scientific Research and Essays; Tree Genetics and Genomes; Weed Research.

5.3.5 Grant reviews for external bodies

- Application for permission to release the leaf-feeding beetle, *Zygogramma bicolorata* (Coleoptera: Chrysomelidae), from quarantine in Cedara, for the biological control of *Parthenium hysterophorus* (Asteraceae), in South Africa (Wilson)
- Application for permission to release the stem-boring weevil, *Listronotus setosipennis* (Coleoptera: Curculiondae) from quarantine at ARC-PPRI Cedara, for the biological control of *Parthenium hysterophorus* (Asteraceae) in South Africa (Wilson)
- Biotechnology and Biological Sciences Research Council (BBSRC), UK. Peer review of grant proposal (Wossler)
- Czech Science Foundation, Expert review of funding proposal (Le Roux)

Estonian Research Council: project evaluations (Richardson)

International Union for the Conservation of Nature (IUCN) - Save our Species (SOS) programme. Expert review of funding proposal (Weyl)

National Geographic Society: project evaluations (Richardson)

5.3.6 Appointment reviews and committees

MacArthur Fellowship Program, USA (Fellowship nomination) (Richardson)

Stellenbosch University, Centre for Invasion Biology: research associate appointment (Foxcroft) University of Ghana, Faculty of Science, professorial promotion, External Assessor, (Chimimba) University of Massachusetts, Amherst, MA, USA; Tenure Assessment (Richardson) University of Pretoria, Faculty of Natural & Agricultural Sciences, Appointments and Promotions

Committee, Permanent Member (Chimimba) University of Zambia, associate professorial appointment (Wossler)

5.3.7 Consulting and other services rendered

CONSULTANCY PRODUCTS

Risk assessment advice for the Department of Environmental Affairs

An increasingly important component of the management of invasive species is the formal assessment of risks associated with particular species becoming invasive when introduced intentionally. The Department of Environmental Affairs contracted the C·I·B to compile guidelines for the assessment and evaluation of risk assessment for alien and invasive species. A system for border control risk assessments is being established under Chapter 6 of the regulations under the National Environmental Management: Biodiversity Act¹ (published for public comment on 3 April 2009). Such risk assessments work as border control instruments and aim to reduce the number of introductions of potentially invasive species into South Africa. Risk assessments have been proven to reduce the costs associated with damage by and control of invasive alien species in other regions of the world; they are a very promising tool also for South Africa. Dave Richardson, Sabrina Kumschick, Elrike Marais and Sarah Davies collaborated on this project. The report titled 'Species-based risk assessments for alien species: A global review of approaches, with recommendations on a strategy for South Africa' was submitted to as part of the contract.

Restoration research for Kew Gardens

Royal Botanical Gardens, UK: In 2012, the C·I·B entered into a new Memorandum of Understanding with Royal Botanical Gardens, Kew (UK), who will fund students researching and helping to implement the restoration of fynbos on alien-invaded and old-field land that has recently become the newly-created Blaauwberg Nature Reserve, Cape Town.

6 Gender impact of research

The Centre staff, post-doctoral associates and students reflect an on-going promotion of the interests of women in science. Women form the majority of all these groups. Much emphasis is also placed on ensuring that women have ample access to opportunities to further their careers. An extremely important although less tangible goal of our Iimbovane Outreach Project is to promote post-school study in the scientific fields, through having regular contact with C·I·B's scientific staff employed in the field, all of whom enjoy their jobs. That the Iimbovane staff members are all women sends a powerful message to young people about traditional gender roles. A participating educator commented: "The Ant ladies [the Iimbovane project team] are role models to our learners, especially the girls. Many girls were inspired to continue with their studies after school". 2012 was a pivotal year for six young women who, having participated in the Iimbovane project, applied and were admitted to Stellenbosch University. These young women have registered in the Department of Botany and Zoology, the Department of Conservation Ecology and Entomology and with the Faculty of Engineering in 2013 (Fig. 11).

¹ Department of Environmental Affairs and Tourism, 2009. National Environmental Management: Biodiversity Act, 2004 - Draft Alien and Invasive Species Regulations. Notice 347 of 2009 published in Government Gazette, No. 32090, 3 April 2009.



Fig. 11. Six of these learners from this inaugural Iimbovane Winter Week group are now first year students at Stellenbosch University. They have enrolled for various SET degrees in 2013, including biological sciences, engineering (both chemical and industrial) and conservation ecology. Photo © Dorette du Plessis.

7 Human resources

7.1 Core team members

Core team members who worked with the Centre during 2012 are shown in the table below. This includes those who joined or resigned during the year.

Name	Citizenship	Institution	Race	Gender	Time spent working in CoE (%)
Prof. Steven Chown*	South Africa	SU	W	М	40
Prof. David Richardson	South Africa	SU	W	Μ	100
Ms Sarah Davies	South Africa	SU	W	F	100
Prof. Chris Chimimba	South Africa	UP	В	Μ	20
Dr Susana Clusella-Trullas	Spain	SU	W	F	25
Prof. Karen Esler	South Africa	SU	W	F	30
Prof. Stefan Foord	South Africa	UniVen	W	Μ	50
Dr Llewellyn Foxcroft	South Africa	SANParks	W	Μ	20
Prof. Charles Griffiths	South Africa	UCT	W	Μ	10
Dr Cang Hui	China	SU	В	Μ	100
Prof. Bettine Jansen van Vuuren	South Africa	SU & UJ	W	F	10
Prof. Steven Johnson	South Africa	UKZN	W	Μ	10
Dr Jaco le Roux	South Africa	SU	W	Μ	50
Prof. Melodie McGeoch*	South Africa	SANParks	W	F	10
Dr Heidi Prozesky	South Africa	SU	W	F	10
Prof. Mark Robertson	South Africa	UP	W	Μ	20
Dr Tammy Robinson	South Africa	SU	W	F	15
Prof. Mathieu Rouget [#]	France	UKZN	W	Μ	-
Prof. Michael Somers	South Africa	UP	W	Μ	10

Name	Citizenship	Institution	Race	Gender	Time spent working in CoE (%)
Prof. Peter Taylor [#]	South Africa	UniVen	W	М	-
Prof. John Terblanche [#]	South Africa	SU	W	Μ	-
Prof. Berndt Janse van Rensburg*	South Africa	UP	W	Μ	55
Dr Brian van Wilgen	South Africa	CSIR	W	Μ	20
Dr Olaf Weyl	South Africa	SAIAB	W	Μ	20
Dr John Wilson	South Africa	SANBI	W	Μ	50
Prof. Theresa Wossler	South Africa	SU	W	F	15

*These core team members resigned from the core team in 2012. [#] These core team members joined late in 2012, and will start their C•I•B projects in 2013.

7.2 Post-doctoral associates

Post-doctoral associates who worked in the Centre during 2012, including those who resigned or completed their work during the year, are shown in the table below.

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	М	100
Dr Rainer Krug	Germany	SU	W	М	100
Dr Jennifer Lee	UK	SU	W	F	100
Dr Sabrina Kumschick	Switzerland	SU	W	F	100
Dr Denise Mager	Austria	SU	W	F	100
Dr Natasha Mavengere	Zimbabwe	SU	В	F	100
Dr Dian Spear	UK	SU	W	F	100
Dr Vernon Visser	SA	SU	W	М	100
Dr Christopher Weldon	Australia	SU	W	М	100
Dr Darragh Woodford	SA	RU	W	М	100
Dr Feng Zhang	China	SU	В	М	100

7.3 Students supported

Name	Citizenship	Institution	Race	Gender	Status
Honours/4 year B. degree:					
Ms Kimberlee Cloete	SA	SU	W	F	Completed
Mr Vhuhwavho Gelebe	SA	UniVen	В	Μ	Continuing
Mr Llewellyn Jacobs	SA	SU	С	Μ	Completed
Ms Monica Leitner	SA	UP	W	F	Completed
Ms Evans Mauda	SA	UniVen	В	Μ	Completed
Mr Melford Mbedzi	SA	UniVen	В	Μ	Pending
Mr Sifiso Mjobo	SA	WSU	В	Μ	Completed
Ms Thembelihle Mlokoti	SA	WSU	В	F	Resigned
Mr Rifilwe Modiba	SA	UniVen	В	Μ	Completed
Mr Vuledzani Mukwevho	SA	UniVen	В	Μ	Completed
Mr Rendani Mulaudzi	SA	SU	В	Μ	Completed
Ms Nthabeliseni Munyai	SA	UniVen	В	F	Pending
Mr Duncan Nengwenani	SA	UniVen	В	М	Completed

Name	Citizenship	Institution	Race	Gender	Status
Mr Audrey Raidani	SA	UniVen	В	F	Pending
Ms Khantse Serobe	SA	UFS	В	F	Pending
Ms Likho Sikutshwa	SA	WSU	В	F	Completed
Ms Lavhelesani Simba	SA	UniVen	В	F	Pending
Masters (MA and MSc):					
Mr Antoine Bahizi	Rwanda	SU	В	М	Submitted
Ms Helene Basson	SA	SU	W	F	Continuing
Ms Samantha de la Fontaine	SA	SU	В	F	Submitted
Mr Jason Donaldson	SA	SU	W	М	Continuing
Mr Muhammed Gardee	SA	SU	В	М	Pending
Ms Enelge Gildenhuys	SA	SU	W	F	Continuing
Mr Brendan Havenga	SA	SU	W	М	Continuing
Ms Marinel Janse van Rensburg	SA	SU	W	F	Continuing
Ms Wilna Jansen	SA	UP	W	F	Pending
Ms Rolanda Julius	SA	UP	В	F	Pending
Ms Haylee Kaplan	SA	SU	W	F	Completed
Ms Asiashu Lithole	SA	UP	В	F	Continuing
Ms Amy Liu	SA	SU	А	F	Continuing
Mr Mashudu Mashau	SA	SU	В	М	Continuing
Ms Vanessa Matukana	SA	UniVen	В	F	Pending
Mr Dickson Mazibuko	Malawi	SU	В	М	Completed
Ms Nokuthula Mbanyana	SA	SU	В	F	Completed
Mr Matthew Miles	SA	UKZN	W	М	Pending
Ms Yongeza Mnini	SA	SU	В	F	Resigned
Mr Mohlamatsane Mokhatla	SA	UP	В	М	Completed
Ms Desika Moodley	SA	SU	В	F	Completed
Ms Savannah Nuwagaba	Uganda	SU	В	F	Completed
Mr Luke Potgieter	SĂ	SU	W	М	Continuing
Mr Dylan Prentice	SA	UP	W	М	Dismissed
Ms Madeleine Ramantswana	SA	SU	В	F	Completed
Ms Elsje Schreuder	SA	SU	W	F	Continuing
Ms Azwinndini Sebola	SA	UniVen	В	F	Pending
Mr George Sekonya	SA	SU	В	М	Continuing
Ms Nolubabolo Tantsi	SA	UP	В	F	Completed
Ms Daisy Thononda	SA	UniVen	В	F	Pending
Mr Allen Tshautshau	SA	SU	В	М	Resigned
MSc-PhD upgrade:					
Ms Genevieve Thompson	SA	SU	W	F	Completed
Ms Jessica Allen	SA	SU	W	F	Continuing
PhD:					
Mr Terence Bellingan	SA	RU	W	М	Continuing
Mr Ryan Blanchard	SA	SU	С	М	Pending
Ms Marguerite Blignaut	SA	SU	W	F	Pending
Mr Emile Bredenhand	SA	SU	W	М	Pending
Mr Bernard Coetzee	SA	SU	W	М	Completed
Mr Andrew Davies	SA	SU	W	М	Continuing
Ms Sarah Davies	SA	SU	W	F	Continuing (P/T)
Ms René Gaigher	SA	SU	W	F	Completed
Ms Carla Gairifo*	Portugal	SU	W	F	Continuing
Ms Tanya Haupt	SA	SU	В	F	Pending
Ms Sanet Hugo	SA	UP	W	F	Completed
Ms Charlene Janion-Scheepers	SA	SU	W	F	Completed

Name	Citizenship	Institution	Race	Gender	Status
Ms Candice Lyons	SA	SU	W	F	Completed
Ms Sandra MacFadyen	SA	SU	W	F	Continuing
Mr Sean Marr	SA	UCT	W	Μ	Completed
Mr Matthew McConnachie	SA	Rhodes	W	Μ	Completed
Mr Gregory McClelland	Canada	SU	W	Μ	Pending
Ms Mandisa Mgobozi	SA	UKZN	В	F	Pending
Ms Onivola Minoarivelo	Madagascar	SU	В	F	Continuing
Mr Phemelo Mogodi	SA	UNW	В	М	Dismissed
Ms Natasha Mothapo	SA	SU	В	F	Pending
Mr Caswell Munyai	SA	UniVen	В	Μ	Continuing
Ms Joyce Ndlovu	Zimbabwe	SU	В	F	Pending
Ms Unjinee Poonen	SA	WITS	В	F	Pending
Ms Andriamihaja Ramanantoanina	Madagascar	SU	В	F	Pending
Mr Sheunesu Ruwanza	Zimbabwe	SU	В	Μ	Completed
Mr Jeremy Shelton	SA	UCT	W	Μ	Pending
Mr Matthys Strydom	SA	SU	W	Μ	Continuing
Mr Farai Tererai	Zimbabwe	SU	В	Μ	Completed
Mr Tsungai Zengeya	Zimbabwe	UP	В	М	Completed
Mr Matthew Zylstra	Australia	SU	W	М	Pending

* Ms Gairifo has visiting student status at Stellenbosch University; she is co-supervised by Prof. Dave Richardson but is registered at a university in Portugal.

7.4 Administrative staff

Name	Institution	Position	Race	Gender
Sarah Davies	SU	Deputy Director: Operations	W	F
Karla Coombe-Davis	SU	Principal Technical Officer: Databases	W	F
Josephine De Mink	SU	Administrative Assistant	В	F
Dorette Du Plessis	SU	Chief Technical Officer: Outreach	W	F
Chantal Ferriera	UP	Technical Officer and Administrative Assistant	W	F
Olivia Fragale	SU	Assistant Technical Officer: Iimbovane	W	F
Mirijam Gaertner	SU	Restoration Ecologist	W	F
Anel Garthwaite	SU	PA to Director, Prof. D.M. Richardson	W	F
Keafon Jumbam	SU	Technical Officer: Iimbovane Outreach Project	В	F
Thembile Khoza	SU	Technical Officer: Long Term Projects	В	F
Suzaan Kritzinger-Klopper	SU	Senior Technical Officer	W	F
Tlou Manyelo*	SU	Technical Officer: Long Term Projects	В	F
Christy Momberg	SU	Management Assistant	W	F
Rhoda Moses*	SU	Administrative Assistant	В	F
Irene Muelelwa*	SU	Assistant Technical Officer: Iimbovane	В	F
Ria Olivier	SU	Social Science Database Assistant	W	F
Erika Nortje	SU	C•I•B Lab Manager	W	F
Charlene Janion-Scheepers	SU	Technical Officer: Norway-Sweden Projects	W	F
Dora Scott	SU	Technical Officer: Antarctic Legacy Project	W	F
Nicole Southgate*	SU	Assistant Technical Officer: Iimbovane	В	F
Mathilda van der Vyver	SU	Administrative Officer	W	F

* These staff resigned during 2012.

Graduate name	Level	Supervisor/host	Position/Organisation
Dr Cécile Berthouly-Salazar	Post-doc	Dr Hui	Post-doctoral researcher, wild pearl millet
			phylogeography and adaptation, Institute for
			Research and Development (IRD), France
Mr Emile Bredenhand	PhD	Prof. Samways	Lecturer, University of the Free State
Ms Haylee Kaplan	MSc	Dr Wilson	Contract with EDRR, SANBI, Cape Town
Dr Jennifer Lee	PhD	Prof. Chown	Environmental Officer, Government of South
			Georgia and South Sandwich Islands;
Ms Monique Masang	MSc	Prof. Griffiths	Extended Curriculum Officer, University of the
			Western Cape
Dr Sean Marr	PhD	Prof. Griffiths	Lecturer, Department of Zoology, University of
			Cape Town
Mr Dickson Mazibuko	MSc	Prof. Richardson	Lecturer, Chancellor College, University of Malawi
Ms Unjinee Poonan	PhD	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,
			Davis
Dr James Rodger	PhD	Prof. Johnson	Post-doctoral Associate, Department of Botany &
			Zoology, Stellenbosch University
Dr Genevieve Thompson	PhD	Prof. Richardson	Post-doctoral researcher, South African
			Environmental Observation Network (SAEON),
			University of Cape Town
Dr Anne Treasure	PhD	Prof. Chown	Post-doctoral Associate, Department of
			Oceanography, University of Cape Town
Dr Dian Spear	Post-doc	Dr Wilson	Climate Change and Environmental Consultant, C4
			EcoSolutions, Cape Town
Dr Charmaine Uys	PhD	Prof. Griffiths	Manager, Grasslands Programme, BirdLife South
			Africa
Ms Julia van der Merwe	MSc	Prof. Wossler	Internship at City of Cape Town
Ms Carlien Vorster	MSc	Prof. McGeoch	Research Assistant, Department of Conservation
			Ecology, Stellenbosch University
Dr Chris Weldon	PhD	Prof. Chown	Lecturer, Department of Zoology & Entomology,
			University of Pretoria

7.5 Resources in the market place

8 Outputs

8.1 Books

Somers, M.J. and Hayward, M.W. (2012). Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? Springer, New York. 320 pp, ISBN: 978-1-4614-0901-4.

8.2 Book chapters

- Chown, S.L. (2012). Insects. In: *Temperature adaptation in a changing climate: Nature at risk*. Storey, K.B. and Tanino, K.K. (eds.). CABI, Wallingford. pp. 45-66.
- Chown, S.L. and Convey, P. (2012). Spatial and temporal variability in terrestrial Antarctic biodiversity. In: Antarctic Ecosystems. An Extreme Environment in a Changing World. Rogers, A.D., Johnston, N.M., Murphy, E.J. and Clarke, A. (eds.). Wiley-Blackwell, Oxford. pp. 13-43.

- Gaertner, M., Holmes, P.M. and Richardson, D.M. (2012). Biological invasions, resilience and restoration. In: *Restoration ecology: the new frontier*. van Andel, J. and Aronson, J. (eds.). Wiley-Blackwell. pp. 265-280.
- Hayward, M.W. and Somers, M.J. (2012). An introduction to fencing for conservation. In: Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? Somers, M.J. and Hayward, M.W. (eds.). Springer, New York. pp. 1-6.
- Pyšek, P. and Richardson, D.M. (2012). Invasive species. In: *Berkshire Encyclopaedia of Sustainability. Vol. 5: Ecosystem Management and Sustainability.* Craig, R.K., Nagle, J.C., Pardy, B., Schmitz, O. and Smith, W. (eds.). Berkshire Publishing Group, Great Barrington, MA. pp. 211-219.
- Somers, M.J., Gusset, M. and Dalerum, F. (2012). Modelling the effect of fences on the viability of spatially structured populations of African Wild Dogs. In: *Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes*? Somers, M.J. and Hayward, M.W. (eds.). Springer, New York. pp. 187-196.

8.3 Articles in peer-reviewed journals

- Allen, J.L., Clusella-Trullas, S. and Chown, S.L. (2012). The effects of acclimation and rates of temperature change on critical thermal limits in *Tenebrio molitor* (Tenebrionidae) and *Cyrtobagous salviniae* (Curculionidae). *Journal of Insect Physiology* 58, 669-678.
- Andresen, L., Everatt, K.T., Somers, M.J. and Purchase, G.K. (2012). Evidence for a resident population of cheetah in the Parque Nacional do Limpopo, Mozambique. South African Journal of Wildlife Research 42, 144-146.
- Becker, P.A., Miller, P.S., Gunther, M.S., Somers, M.J., Wildt, D.E. and Maldonado, J.E. (2012). Inbreeding avoidance influences the viability of reintroduced populations of African Wild Dogs (*Lycaon pictus*). *PLoS One* 7, e37181. DOI: 10.1371/journal.pone.0037181.
- Beekman, M., Allsopp, M.H., Holmes, M.J., Lim, J., Noach-Pienaar, L.A., Wossler, T.C. and Oldroyd, B.P. (2012). Racial mixing in South African honeybees: The effects of genotype mixing on reproductive traits of workers. *Behavioral Ecology and Sociobiology* 66, 897-904.
- Bengtsson, J., Janion, C., Chown, S.L. and Leinaas, H.P. (2012). Litter decomposition in fynbos vegetation, South Africa. *Soil Biology and Biochemistry* **47**, 100-105.
- Berthouly-Salazar, C., Cassey, P., Jansen van Vuuren, B., van Rensburg, B.J., Hui, C., Gardner, M.G. and Le Roux, J.J. (2012). Development and characterization of 13 new, and cross amplification of 3, polymorphic nuclear microsatellite loci in the common myna (*Acridotheres tristis*). *Conservation Genetics Resources* **4**, 621-624.
- Berthouly-Salazar, C., Thevenon, S., Thu Nhu, V., Binh Trong, N., Lan Doan, P., Cuong Vu, C. and Maillard, J.-C. (2012). Uncontrolled admixture and loss of genetic diversity in a local Vietnamese pig breed. *Ecology and Evolution* 2, 962-975.
- Berthouly-Salazar, C., van Rensburg, B.J., Le Roux, J.J., Jansen van Vuuren, B. and Hui, C. (2012). Spatial sorting drives morphological variation in the invasive bird, *Acridotheris tristis. PLoS One* 7, e38145. DOI: 10.1371/journal.pone.0038145.
- Boardman, L., Terblanche, J.S., Hetz, S.K., Marais, E. and Chown, S.L. (2012). Reactive oxygen species production and discontinuous gas exchange in insects. *Proceedings of the Royal Society B-Biological Sciences* **279**, 893-901.
- Born, C., Le Roux, P.C., Spohr, C., McGeoch, M.A. and Jansen van Vuuren, B. (2012). Plant dispersal in the sub-Antarctic inferred from anisotropic genetic structure. *Molecular Ecology* 21, 184-194.

- Braschler, B., Chown, S.L. and Gaston, K.J. (2012). The fynbos and succulent karoo biomes do not have exceptional local ant richness. *PLoS One* 7, e31463. DOI: 10.1371/journal.pone.0031463.
- Brettschneider, H., Anguelov, R., Chimimba, C.T. and Bastos, A.D. (2012). A mathematical epidemiological model of gram-negative Bartonella bacteria: Does differential ectoparasite load fully explain the differences in infection prevalence of *Rattus rattus* and *R. norvegicus? Journal of Biological Dynamics* **6**, 763-781.
- Brettschneider, H., Bennett, N.C., Chimimba, C.T. and Bastos, A.D.S. (2012). Bartonellae of the Namaqua rock mouse, *Micaelamys namaquensis* (Rodentia: Muridae) from South Africa. *Veterinary Microbiology* 157, 132-136.
- Catford, J.A., Vesk, P.A., Richardson, D.M. and Pyšek, P. (2012). Quantifying levels of biological invasion: Towards the objective classification of invaded and invasible ecosystems. *Global Change Biology* **18**, 44-62.
- Chamier, J., Schachtschneider, K., Le Maitre, D.C., Ashton, P.J. and van Wilgen, B.W. (2012). Impacts of invasive alien plants on water quality, with particular emphasis on South Africa. *Water SA* 38, 345-356.
- Chang, C.S., Chen, C.F., Berthouly-Salazar, C., Chazara, O., Lee, Y.P., Chang, C.M., Chang, K.H., Bed'Hom, B. and Tixier-Boichard, M. (2012). A global analysis of molecular markers and phenotypic traits in local chicken breeds in Taiwan. *Animal Genetics* **43**, 172-182.
- Chown, S.L. (2012). Antarctic marine biodiversity and deep-sea hydrothermal vents. *PLoS Biology* **10**, e1001232, 4 pages. DOI: 10.1371/journal.pbio.1001232.
- Chown, S.L. (2012). Trait-based approaches to conservation physiology: Forecasting environmental change risks from the bottom up. *Philosophical Transactions of the Royal Society B-Biological Sciences* **367**, 1615-1627.
- Chown, S.L., Huiskes, A.H.L., Gremmen, N.J.M., Lee, J.E., Terauds, A., Crosbie, K., Frenot, Y., Hughes, K.A., Imura, S., Kiefer, K., Lebouvier, M., Raymond, B., Tsujimoto, M., Ware, C., van de Vijver, B. and Bergstrom, D.M. (2012). Continent-wide risk assessment for the establishment of nonindigenous species in Antarctica. *Proceedings of the National Academy* of Sciences of the United States of America 109, 4938-4943.
- Chown, S.L., Le Roux, P.C., Ramaswiela, T., Kalwij, J.M., Shaw, J.D. and McGeoch, M.A. (2012). Climate change and elevational diversity capacity: Do weedy species take up the slack? *Biology Letters* 9, 20120806, 4 pages. DOI: 10.1098/rsbl.2012.0806.
- Chown, S.L., Lee, J.E., Hughes, K.A., Barnes, J., Barrett, P.J., Bergstrom, D.M., Convey, P., Cowan, D.A., Crosbie, K., Dyer, G., Frenot, Y., Grant, S.M., Herr, D., Kennicutt, M.C., II, Lamers, M., Murray, A., Possingham, H.P., Reid, K., Riddle, M.J., Ryan, P.G., Sanson, L., Shaw, J.D., Sparrow, M.D., Summerhayes, C., Terauds, A. and Wall, D.H. (2012). Challenges to the future conservation of the Antarctic. *Science* 337, 158-159.
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8.4 Published conference proceedings

- Esler, K.J., Blignaut, J., de Wit, M.P., Milton, S.J., Le Maitre, D., Mitchell, S. and Crookes, D. (2012). The impact of re-establishing indigenous plants and restoring the natural landscape on sustainable rural employment and land productivity through payment for environmental services. In: Land Use and Nature Conservation Proceedings of the 2nd International Workshop of the Quality Network Biodiversity in Sub-Sahara Africa. Arbeitsberichte des Geographischen Instituts der Humboldt Universität Berlin, Heft 175. (eds. Dannenberg, P., Göttert, T., Nduru, G. and Zeller, U.). p. 65.
- Foxcroft, L.C., Jarošík, V., Pyšek, P., Richardson, D.M., Rouget, M. and MacFadyen, S. (2012). Plant invasions in Kruger National Park, South Africa: the role of boundaries, general predictors

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- Ivey, P., Wilson, J.R., Nänni, I. and Geber, H. (2012). Early experiences in the establishment of a National Early Detection and Rapid Response Programme for South Africa. In: 2nd International workshop on invasive plants in the Mediterranean type regions of the world. Trabzon, Turkey. (eds. Brunel, S., Uludag, A., Fernandez-Galiano, E. and Brundu, G.). pp. 175-191.
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 Molecular research as tool for managing biological invasions: *Acacia saligna* as a case study.
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8.5 Published conference abstracts

- Esler, K.J., Blignaut, J., de Wit, M., Milton, S., le Maitre, D., Mitchell, S. & Crookes, D. (2012) The impact of re-establishing indigenous plants and restoring the natural landscape on sustainable rural employment and land productivity through payment for environmental services. In: Dannenberg, P., Göttert, T., Nduru, G.& Zeller, U. (Eds). Land Use and Nature Conservation Proceedings of the 2nd International Workshop of the Quality Network Biodiversity in Sub-Saharan Africa. Arbeitsberichte des Geographischen Instituts der Humboldt Universität Berlin, Heft 175. Karatina. p. 65. ISSN 0947 0360
- Geerts, S., Wilson, J. R., Richardson, D. M., McGeoch, M., Gaertner, M., Le Roux, J. J., Kritzinger-Klopper, S. & Muofhe, C. (2012) *Banksia ericifolia* invading South Africa as predicted - A major threat or just symptom of a peculiar fire regime? *South African Journal of Botany*, **79**, 186-187.
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- Wilson, J. R., Ivey, P., Nanni, I. & Manyama, P. (2012) Biological invasion assessment and eradication - A national programme to reduce South Africa's invasion debt. South African Journal of Botany, 79, 222-222.

8.6 Products / artifacts / patents

None

8.7 Conferences / meetings attended

8.7.1 International plenary/keynote addresses

- Foxcroft, L.C. Biological invasions in South Africa and its National Parks. Keynote address at the New Zealand Biosecurity Institute NETS conference, New Zealand, July 2012.
- Foxcroft, L.C. The Kruger Experience: Problems & Solutions to Biological Invasions. Keynote address at the New Zealand Biosecurity Institute NETS conference, New Zealand, July 2012.
- Prozesky, H. & Van der Watt, L. The triple burden of masculinity: a gender analysis of South African Antarctic and sub-Antarctic science, c. 1961-2011. First Lewander Lecture at the XXXII Scientific Committee of Antarctic Research Open Science Conference, Portland, Oregon, July 2012.
- Richardson, D.M. Managing invasive trees: Changing approaches, priorities and challenges from around the world. Plenary address at 7th European Conference on Biological Invasions (Neobiota) 'Halting biological invasions in Europe: From data to decisions', Pontevedra, Spain, September 2012.

8.7.2 National plenary/keynote addresses

None

8.7.3 International oral contributions

- Clusella-Trullas, S. Macrophysiology of reptiles. Seminars in Zoophysiology (Invited speaker). Aarhus University, Denmark, April 2012.
- Davies, S.J., Clusella-Trullas, S. & McGeoch, M.A. Painted into a corner? Physiological tolerance limits spread in a sub-tropical amphibian *Hyperolius marmoratus*. 7th World Congress of Herpetology, Vancouver, Canada, August 2012.
- Donaldson, J. E. First impressions count: assessing the role of introduction history in structuring the invasive distributions of Australian Acacia species in South Africa. Tree Invasions Workshop, Bariloche, Argentina, 3-6 September 2012
- Ellender BR, Weyl OLF (2012) Impact of centrarchid invasion on an endangered South African fish *Pseudobarbus afer* in headwater streams. In: International Conference on Ecology and Conservation of Freshwater Fish, 28 May-2 June 2012. Vila Nova de Cerveira, Portugal.
- Esler, K.J., Blignaut, J., de Wit, M., Milton, S., le Maitre, D., Mitchell, S. & Crookes, D. The impact of re-establishing indigenous plants and restoring the natural landscape on sustainable rural employment and land productivity through payment for environmental services. 2nd International Workshop of the Quality Network Biodiversity in Sub-Sahara Africa. Karatina, Kenya, October 2012.

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- Kaplan, H., van Niekerk A., Le Roux, J., Richardson, D., Wilson, J. R. Incorporating risk mapping at multiple spatial scales into eradication management plans. Tree invasions – patterns & processes, challenges & opportunities, Bariloche, Argentina, 3–6 September 2012
- Kumschick, S., Bacher, S., Dawson, W., Heikkilä, J., Sendek, A., Pluess, T, Robinson, T.B. & Kühn,I. A conceptual framework for prioritization of invasive alien species for management.NEOBIOTA conference, Pontevedra, Spain, September 2012.
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- Mothapo, N.P., Joubert, C. and Wossler T.C. The Argentine ant, *Linepithema humile*, interferes with the foraging success of native ant species in a biodiversity hotspot. 24th International Congress of Entomology, South Korea, August 2012.
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- Robertson, M.P. Insect and spider diversity across an altitudinal gradient in the Maloti-Drakensberg mountains. Mountain research workshop, Mohale Dam, Likalaneng, Lesotho, August 2012.
- Robertson, M.P., Rouget, M. Richardson, D.M., Wilson, J.R.U. Hui, C. Quantifying invasion debt for alien trees. Workshop on tree invasions – patterns & processes, challenges & opportunities, Hostería Isla Victoria, Isla Victoria Island, Nahuel Huapi National Park, Bariloche, Argentina, September 2012.
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- Somers, M.J., Swanepoel, L. & Hayward, M.W. (2012). Fences as hard and soft edges for wildlife. International Wildlife Management Congress, Durban, South Africa, July 2012.
- Wilson, J. R. Getting the measure of tree invasions. Tree invasions patterns & processes, challenges & opportunities, Bariloche, Argentina, 3–6 September 2012.
- Wilson, J. R. Post-border assessments—developing a protocol for South Africa. Workshop on Rapid Response, Early Detection, and Risk Assessment of Invasive Alien Species, Wallenberg Centre, Stellenbosch, 6 – 7 August 2012.

8.7.4 National oral contributions

- Bahizi, A. & Hui, C. (2012) Assessing the impact of temperature change on regional and global biodiversity: a meta-analysis. 55th Annual Congress of the South African Mathematical Society (SAMS), Stellenbosch, South Africa.
- De la Fontaine, S., Esler, K.J., Malgas, R. (2012) An investigation into the socio-economic impact of invasive alien plants on the rural Agulhas Plain. Fynbos Forum, Cape St Francis, 16-19 July 2012.
- Dreber, N. & Esler, K.J. (2012) Effects of overgrazing, habitat transformation and rainfall on the structure and spatial patterning of soil seed banks: a fence-line contrast approach from arid Namibia. 47th Annual conference of the Grassland society of southern Africa, Club Mykonos, Langebaan, Western Cape, July 2012
- Ellender BR, Weyl OLF, Nagelkerke LAJ. 2012. Assessing the consequences of non-native fish invasion to the endangered border barb Barbus trevelyani in the Keiskamma River system, easter cape, south Africa. South African Society of Aquatic Science. Cape St Francis Resort, Eastern Cape, South Africa, 1-5 July 2012
- Foord, S.H. & Dippenaar-Schoeman, A.S. 2012. Drivers of spider diversity along an elevational transect in a floristic kingdom sensitive to climate change. DST/NRF National Conference on Global Change, Boksburg, November 2012
- Forsyth, GG and van Wilgen BW (2012) The prioritization of invasive alien plant control projects using a multi-criteria decision model informed by stakeholder input and spatial data. Biodiversity Planning Forum, Skukuza
- Foxcroft, L.C., Spear, D., van Wilgen, N. & McGeoch, M.A. (2012) Potential pathways and impacts of alien plant invasions in South African National Parks. 10th Kruger National Park Science Network Meeting, Skukuza, March 2012
- Gildenhuys, E., Scott, C.P, Ellis, A.G. and Le Roux, J.J. Unravelling phylogeography uncertainties for the genus Cardiospermum: a phylogenetic and biological approach. 40th Annual Symposium on Management of Invasive Alien Plants, April 2012
- Janse van Rensburg, M. & Hui, C. (2012) Reconstructing the range expansion of the invasive European starling in South Africa using a hybrid method of niche modeling and stochastic cellular automaton. 55th Annual Congress of the South African Mathematical Society (SAMS), Stellenbosch, South Africa.
- Jansen van Vuuren, B. Genetic management of game species: Is this important on game farms and conservation parks and should we care? Southern African Wildlife Management Association Symposium, Bela-Bela, South Africa, September 2012.
- Kalwij, J. M, Robertson, M. P. van Rensburg, B. J. (2012) Rapid colonization by annual alien plants of a high montane roadside in the Drakensberg, South Africa. South African Association of Botanists – Annual meeting 2012, Pretoria, January 2012.
- Kumschick, S. & Richardson, D. Risk assessments for invasive alien species: A global review of approaches, with recommendations on a strategy for South Africa. Workshop on Rapid Response, Early Detection, and Risk Assessment of Invasive Alien Species, Wallenberg Centre, Stellenbosch, South Africa, August 2012.
- Mayer K., Schurr F.M., Esler K.J. (2012) A trait-based analysis of fecundity schedules in serotinous Proteaceae of the Fynbos biome: Relevance to fire management. Fynbos Forum, Cape St Francis, 16-19 July 2012
- Modiba, R.V, Foord, S.H. The response of benthic macroinvertebrates and adult odonata to alien invasive clearing. 4th SAEON Graduate Student Network Indibano, 26-29 August 2012, WESSA Umgeni Valley Nature Reserve, Kwazulu-NatalMinoarivelo, H.O., Hui, C. &

Scheffler, K. (2012) A Markov process model of the evolution of ecological networks. 55th Annual Congress of the South African Mathematical Society (SAMS), Stellenbosch, South Africa.

- Munyai T.C, Foord, S.H. & Baxter, R.M. Ant diversity and ecosystem services across an levational gradient, functional versus taxonomic perspective in the Soutpansberg Mountain, South Africa. 4th SAEON Graduate Student Network Indibano, 26-29 August 2012, WESSA Umgeni Valley Nature Reserve, Kwazulu-Natal.
- Nottebrock H., Schmid B., Esler K.J., Böhning-Gaese K., Schleuning M., Schurr F.M. (2012) How do plant-plant and plant-pollinator interactions affect the fecundity of Protea individuals? Fynbos Forum, Cape St Francis, 16-19 July 2012
- Nuwagaba, S., Zhang, F. & Hui, C. (2012) Interaction switch depicts the architecture of antagonistic networks. 55th Annual Congress of the South African Mathematical Society (SAMS), Stellenbosch, South Africa.
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- Potgieter, L.J., Richardson, D.M., & Wilson, J.R.U. The genus Casuarina in South Africa: introduction history, distribution, invasion dynamics and management implications. 40th Annual Weeds Symposium, Stellenbosch, South Africa, April 2012.
- Rebelo, A.J., Le Maitre, D., Esler, K.J., Cowling, R.M. (2012) Restoration as an essential insurance policy: a case study of the Upper Kromme. Fynbos Forum, Cape St Francis, 16-19 July 2012
- Sandberg, R.N., Allsopp, N., Bond, W.J., Esler, K.J. (2012) Response of biotic communities to natural and anthropogenic habitat fragmentation. Fynbos Forum, Cape St Francis, 16-19 July 2012
- Schmid B. Nottebrock H., Esler K.J., Pauw, A., Böhning-Gaese K., Schurr F., Schleuning M. (2012) Sugarbush and Sugarbirds: a delicate win-win relationship in South African fynbos? Fynbos Forum, Cape St Francis, 16-19 July 2012
- Schurr, F. M., Nottebrock H., Pagel, J., Schmid B., Mayer, K., Treurnicht, M., Böhning-Gaese K., Esler K.J., Midgley, G.F., Schleuning M., Rebelo, A.G. (2012) The value of Proteaceae for the understanding and conservation of Fynbos ecosystems. Fynbos Forum, Cape St Francis, 16-19 July 2012
- Taylor GC, Weyl OLF. 2012. The validation of growth zone deposition rate in sagittal otoliths and an evaluation of scales as an alternative ageing structure for south african largemouth bass (*Micropterus salmoides*) populations. South African Society of Aquatic Science. Cape St Francis Resort, Eastern Cape, South Africa, 1-5 July 2012
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- Van Wilgen, B.W. (2012). Invasive alien plants as drivers of land cover change: trends and consequences. Annual conference of the South African Association of Botanists, University of Pretoria.
- Van Wilgen, B.W. (2012). An assessment of the effectiveness of Working for Water in controlling invasive alien plants in South Africa 40th annual symposium on management of invasive alien plants, Stellenbosch
- Van Wilgen, B.W. (2012). An assessment of the effectiveness of Working for Water in controlling invasive alien plants in South Africa. Biodiversity Planning Forum, Skukuza
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- Weyl, O.L.F., Woodford, D.J., Ellender, B.R. 2012. Invasive alien smallmouth bass in the Rondegat stream: impacts, efficacy of removal and future prospects. South African Society of Aquatic Science. Cape St Francis Resort, Eastern Cape, South Africa, 1-5 July 2012
- Wilson, J. R., Ivey, P., Nanni, I. & Manyama, P. (2012) Biological invasion assessment and eradication - A national programme to reduce South Africa's invasion debt. South African Association of Botanists – Annual meeting 2012 University of Pretoria, South Africa, 15–18 January 2012
- Woodford, D.J., Weyl, O.L.F., Hui, C. 2012. Patterns of introduced fish establishment across an artificial irrigation network: a model system for understanding fish invasions. South African Society of Aquatic Science. Cape St Francis Resort, Eastern Cape, South Africa, 1-5 July 2012
- Woodford, D.J., Weyl, O.L.F., Bellingan T., De Moor F.C., Day J.A., Gouws J. 2012. Monitoring the effects of piscicide operations on the invertebrate fauna of the Rondegat River. South African Society of Aquatic Science. Cape St Francis Resort, Eastern Cape, South Africa, 1-5 July 2012
- Yapi, T., O'Farrell, P., Dziba, L.E. & Esler, K.J. (2012) Assessing the impacts of Acacia mearnsii (Dywabase; Black wattle) on grazing provision and livestock production in South Africa. 47th Annual conference of the Grassland society of southern Africa, Club Mykonos, Langebaan, Western Cape, July 2012

8.7.5 International posters

- Davies S.J., Clusella-Trullas S., McGeoch M.A. Thermal tolerance and phenotypic plasticity of an invasive anuran: the painted reed frog (*Hyperolius marmoratus*). African Amphibian Working Group, Trento, Italy, May 2012.
- Jansen van Vuuren, B., Janion, C., Porco, D., Carapelli, A., Bedos, A. & Deharveng, L. Isotomurus maculatus: DNA evidence solves some of the confusion and adds additional questions. International Colloquium on Apterygota, Coimbra, Portugal, August 2012.
- Mager, D.M., Hui, C., Esler, K.J. (2012) A first record of biological soil crusts in the Cape Floristic Region, South Africa. T2.43. Aboveground-belowground interactions: technologies and new approaches. Joint Meeting of the British Ecological Society, the Biochemistry Society and the Society of Experimental Biology, London, UK.
- Potgieter, L.J., Richardson, D.M., & Wilson, J.R.U. *Casuarina*: biogeography and ecology of an important tree genus in a changing world. Tree Invasion Workshop, Bariloche, Argentina, September 2012.
- Scott, D., Van der Watt, L., Cooper, J., Prozesky, H., Swart, S., Chown, S. Breaking out: on building a digital platform for South African Antarctic history. XXXII Scientific Committee of Antarctic Research Open Science Conference, Portland, Oregon, July 2012.
- Somers, M.J., Swanepoel, L. & Hayward, M.W. (2012). Fences as hard and soft edges for wildlife. International Wildlife Management Congress, Durban, South Africa, July 2012.
- Taylor GC, Weyl OLF & Cowley PD. 2012. Biology of non-native largemouth bass *Micropterus salmoides* in Southern Africa. In: Ecology and Conservation of Freshwater Fish: 28 May-2 June 2012. Vila Nova de Cerveira, Portugal.
- Tererai, F., Gaertner, M. Jacobs, S.M., & Richardson D.M. *Eucalyptus* invasions in riparian forests: floristic diversity, stand structure and compositional changes in native vegetation. NEOBIOTA 7th European Conference on invasive alien species, Pontevedra, Spain, September 2012.

Visser, V. & Richardson, D.M. Google Earth as a tool in invasion science. Workshop on Tree Invasions – Patterns & Processes, Challenges & Opportunities, Isla Victoria, Bariloche, Argentina, September 2012.

8.7.6 National posters

- Dippenaar-Schoeman, A.S., Foord, S.H. & Lyle, R. 2012. The spiders (Arachnida: Araneae) of Venetia Limpopo Nature Reserve. 3RD De Beers Diamond Route Research Conference, Johannesburg, South Africa, 30-31 October 2012.
- Maoela, M.A., Esler, K.J., Jacobs, S.M., Roets, F. (2012) Insect herbivory and leaf pathogens in riparian zones of the Western Cape Province. Fynbos Forum, Cape St Francis, 16-19 July 2012.
- Potgieter, L.J., Richardson, D.M., & Wilson, J.R.U. *Casuarina*: biogeography and ecology of an important tree genus in a changing world. Centre of Excellence for Invasion Biology Annual Research Meeting, Stellenbosch, South Africa, November 2012.

8.8 Other relevant outputs

8.8.1 Popular articles and talks

ARTICLES

Anonymous. 2012. 'No' to forestry in fynbos areas. SA Forestry, June 2012, pp. 6.

- Anonymous. 2012. New leader for Stellenbosch Centre investigating invasive species. *Water Wheel*, July 2012, pp. 7.
- Anonymous. 2012. New leader picks up Centre's Baton. Urban Green File, August 2012, pp. 4.
- Anonymous. 2012. Seabird expert honoured. Fishing Industry News, April 2012, pp. 29.
- Anonymous. 2012. Seabird expert honoured. Submerge, June 2012, pp. 10.
- Coetsee, J. 2012. Dit bepaal biodiversiteit. Landbouweekblad, Januarie 2012, pp. 68.
- Duvenage, E. 2012. Uitheemse spreeus neem oor. AgriFokus, September 2012, pp. 8.
- Genis, A. 2012. Indringers bedreig selfs Antarktika. Landbouweekblad, November 2012, pp. 10.
- Lucas, M. & Griffiths, C.L. 2012. Environmental change its effects on species distribution.

Quest, Volume 8(2), pp. 40.

Ryan, P. & Wanless, R. Gill Memorial Award: John Cooper. *African Birds and Birding*, June 2012, pp. 66.

TALKS

- Foxcroft, L.C. Invasive alien species: research and management in Kruger National Park. Organisation for Tropical Studies, Skukuza, Kruger National Park, February 2012.
- Foxcroft, L.C. Invasive alien species: research and management in Kruger National Park. Organisation for Tropical Studies, Skukuza, Kruger National Park, September 2012.
- Jansen van Vuuren, B. Genetic structure in animals. Invited popular talk at the Trophy Breeders' Seminar held at the Atterbury Theatre, Pretoria, July 2012.
- Mothapo, N.P. Accidental tourist: Argentine ants launch a hostile take-over in the Fynbos. Invited popular talk at 'New Voices in Science' competition, Stellenbosch University, STIAS, December 2012.
- Weyl, O.L.F. (2012) Restoration in rivers and estuaries. Water Research Commission WRC Workshop 87: Ecological Restoration. The Strand Municipality (26/09/2012)
- Weyl, O.L.F. (2012) Bass research on Wriggleswade Dam. South African Bass Anglers Association, Wriggleswade Dam, Stutterheim. (24/09/2012).

8.9 NRF Service Provision

8.9.1 Rating and project proposal reviews

Conservation and management of Ecosystems and Biodiversity: project proposal reviews (2) (Chimimba)

Focus Area - Blue Skies: project proposal review (Robertson)

Focus Area - NRF Thuthuka: project proposal reviews (3) (Jansen van Vuuren, Somers)

Focus Area - Plant Sciences: Project Proposal Review (1) (Esler)

Focus Area - SEAChange (Jansen van Vuuren)

NRF Rating reviews (17) (Esler, Griffiths, Jansen van Vuuren, Richardson, van Wilgen, Weyl, Wossler)

South Africa / Egypt bilateral funding review of one grant submission 2012 (Wilson) SEAChange Funding application review (Robinson)

8.9.2 Panel and committee service

SARChI Review Panel (Robinson)

SEAChange Panel Member (Griffiths)

Plant sciences rating panel (Johnson)

Thuthuka Panel: Agriculture (Jansen van Vuuren)

8.10 Media interactions

8.10.1 Newspaper articles

Anoniem. 2012. Antarktika word bedreig. Nuus Nou. 22 Maart 2012.

- Anoniem. 2012. Bosbou in fynbosstreke 'is nie omgewingslim'. Sake24 (Burger). 24 Mei 2012.
- Anoniem. 2012. Bosbou in fynbosstreke nie die koste werd. Sake 24 (Beeld). 24 Mei 2012.
- Anoniem. 2012. Indringerbesoekers aan koue vasteland. Rapport. 11 Maart 2012.
- Anoniem. 2012. Kenner gesels oor klimaat. Tygerburger (Belville). 29 Februarie 2012.
- Anoniem. 2012. Voëlringers, voëlkykers kan help met studies oor indringerspesies. Plattelander. 21 September 2012.
- Anoniem. 2012. Voëlringers, voëlkykers kan help met studies oor indringerspesies. Suid Kaap Forum. 5 Oktober 2012.
- Anoniem. 2012. VSA-kenner gesels oor klimaat. Tygerburger (Milnerton). 29 Februarie 2012.
- Anoniem. 2012. VSA-kenner gesels oor klimaat. Tygerburger (Table View). 29 Februarie 2012.
- Anonymous. 2012. Birders can help with alien species studies. Table Talk. 17 October 2012.
- Anonymous. 2012. Birders can help with alien species studies. Vukani. 9 November 2012.
- Anonymous. 2012. Call for help to study birds. Fisherhaven/Hawston/Kleinmond/Bettysbaai/

Pringlebaai/Rooiels Gazette. 25 September 2012.

Anonymous. 2012. Climate Change. District Mail. 8 March 2012.

- Anonymous. 2012. Invaders. News Now. 22 March 2012.
- Anonymous. 2012. Stopping invaders from taking over. Mail & Guardian (Supplement). 9 November 2012.
- Anonymous. 2012. Talk on climate change issues. Bolander. 29 February 2012.
- Blaine, S. 2012. Sea life hangs in balance on icy islands. Business Day. 2 November 2012.
- Duvenage, E. 2012. Antarktika verkeer onder druk. Burger (Buite). 12 Junie 2012.
- Duvenage, E. 2012. Birders can help with alien species studies. Athlone News, 14 January 2012.
- Duvenage, E. 2012. Two honours for invasion biologist. Bolander 14 November 2012.
- Gouws, H. 2012. US begin projek oor Antarktika. Burger (Kaap Stedelik), 27 Januarie 2012.
- Gouws, H. 2012. US begin projek oor Antarktika. Burger (Oos Kaap), 27 Januarie 2012.
- Kotze, P. 2012. Ants teach kids a lesson. SANParks Times. September 2012.

Kotze, P. 2012. There are aliens on Table Mountain. SANParks Times. September 2012.

Krige, I. 2012. Miernavorsing beïndruk Pandor. Burger (Platteland). 22 Februarie 2012.

Krige, I. 2012. Miernavorsing beïndruk Pandor. Burger (Suid Kaap). 22 Februarie 2012.

Richardson, D. 2012. The war against invaders is evolving. Cape Times. 9 November 2012.

Staff reporter. 2012. Academics all for help of 'citizen scientists'. Cape Argus. 25 September 2012.

Venter, M. 2012. Kenner van voëls vereer. Burger (Kaap Stedelik). 27 Maart 2012.

Venter, M. 2012. Seevoëlkenner vereer vir sy navorsing. Burger (Kaap Platteland). 25 Februarie 2012.

Venter, M. 2012. Seevoëlkenner vereer vir sy navorsing. Burger (Suid Kaap). 25 Februarie 2012.

Wild, S. 2012. Scientists at loggerheads over pine tree invasion claims. Business Day. 18 June 2012.

Yeld, J. 2012. Seabird expert honoured. Sunday Weekend Argus. 22 April 2012.

8.10.2 Newsletters

- Anonymous. 2012. Book: Fencing for conservation. Southern African Wildlife Management Association. March 2012.
- Anonymous. 2012. Visitors, invasive species and climate change threaten pristine Antarctica. Southern African Wildlife Management Association. March 2012.

8.10.3 Articles published by Stellenbosch University

ELECTRONIC RESOURCES

- Anonymous. 2012. 'Alien invasion' a threat to Antarctic ecosystem. *Business World Weekender*, [online] 8 March 2012. Available at: <<u>http://www.bworldonline.com/weekender/content.php?id=48006</u>> [Accessed on 6 February 2013].
- Anonymous. 2012. 'No' to forestry in fynbos areas. *The Green Times*, [online] 7 June 2012. Available at: www.thegreentimes.co.za/stories/trees/item/1327-%E2%80%9Cno%E2%80%9D-to-forestry-in-fynbos-areas> [Accessed on 7 June 2012].
- Anonymous. 2012. A passion for science. *Mail & Guardian*, [online] 15 February 2012. Available at: <<u>http://mg.co.za/article/2012-02-15-a-passion-for-research</u>> [Accessed on 20 February 2012].
- Anonymous. 2012. Alien 'hitchhikers' invading Antarctica's pristine frontier. *The Daily Galaxy*, [online] 6 March 2012. Available at: <<u>http://www.dailygalaxy.com/my_weblog/2012/03/-</u> <u>ecoalert-alien-hitchikers-invading-antarcticas-pristine-frontier-.html</u>> [Accessed on 6 February 2013].
- Anonymous. 2012. Alien species invading Antarctica via tourists, scientists. *National Geographic News*, [online] 5 March 2012. Available at: <<u>http://news.nationalgeographic.com/news/2012/03/120305-antarctica-invasive-species-</u> environment-science-tourists/> [Accessed on 24 January 2013].
- Anonymous. 2012. Alien species invading Antarctica via tourists, scientists. *Ohio Wesleyan University – Environmental Geography Homepage*, [online] 10 March 2012. Available at: < <u>http://environmentalgeography.wordpress.com/2012/03/10/alien-species-invading-antarctica-via-tourist-scientists-17/> [Accessed on 6 February 2013].</u>
- Anonymous. 2012. Alien species invading Antarctica via tourists, scientists. *TechTrend*, [online] 23 March 2012. Available at: <<u>http://www.techtrend24.com/alien-species-invading-antarctica-via-tourists-scientists/</u>> [Accessed on 6 February 2013].
- Anonymous. 2012. Alien species threaten the Antarctic ecosystem. *Antartida Urbana*, [online] 16 March 2012. Available at: <<u>http://www.antartidaurbana.com/a/ciencia/especies-invasivas-amenazan-el-ecosistema-antartico?lang=en</u>> [Accessed on 5 April 2012].

- Anonymous. 2012. Antarctica sees an influx of invading life. *UPI.com*, [online] 6 March 2012. Available at: < <u>http://www.upi.com/Science_News/2012/03/06/Antarctica-sees-an-influx-of-invading-life/UPI-42051331067594/</u>> [Accessed on 6 February 2013].
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- Anonymous. 2012. Expert honoured for lifetime's seabird research. *University of Cape Town News*, [online] 12 March 2012. Available at: <<u>http://www.uct.ac.za/dailynews/?id=8056</u>> [Accessed on 5 April 2012].
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RADIO AND TELEVISION

- Chown, S.L. Interviewed on Radio Sonder Grense (Monitor) concerning invasive alien species on Antarctica, May 2012.
- Chown, S.L. Interviewed on the John Maytham Show (CapeTalk567) concerning the eradication of an invasive alien louse on Marion Island, April 2012.
- Chown, S.L. Interviewed on The John Robbie Show on TalkRadio702 concerning invasive alien species in Antarctica, March 2012.
- Chown, S.L. Interviewed on the Midday Report by Chris Gibbons, on TalkRadio702 concerning invasive alien species in Antarctica, March 2012.
- Jansen van Vuuren, B. Interviewed on Radio Sonder Grense (Ekoforum), about the impact of global warming and human impact on the natural environment of Madagascar, March 2012.
- Mothapo, N.P. 2012. Interview on Lesedi FM (SABC Radio) concerning her work on Argentine ants and their potential threat to the Fynbos, October, 2012.
- Pepler, D. Interviewed on the Radio Sonder Grense (Dink Groen) on earthworms as invasive alien species, August 2012.
- Prozesky, H.E. Participant in *Woordfees Diskoers* on *Hoe lewe 'n mens groen*, broadcast on *Radio Sonder Grense*, March 2012.
- Van Wilgen, B. Interviewed on Radio Sonder Grense (Monitor) about the impacts of forestry on fynbos areas, June 2012.

9 Stage progress

Progress according to Service Level Agreement No. 5 of 5 (2012-2014). 2012: was the first year of Stage 5.

TIMEFRAMES

The pending Gate review (Gate 5) shall take place during February or March 2015.

Two CoE Advisory Board (virtual or real) meetings should take place per annum during this Stage, typically during March and November of each year.

2012: Board meetings were held on 15 March and 1 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. 2012: Student lists were provided on 28 March (provisional) and 3 July (final) 2012.

The CoE will publish 'nuggets' of information on its website and provide these at six-monthly intervals to the NRF.

2012: Nuggets were sent to the NRF on 23 April, 20 July and 5 December 2012

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. 2012: Audited statements will be presented to the Board on 28 March 2013.

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. 2012: Monthly cash flow statements were submitted for January to December.

REPORTS DUE IN THIS STAGE

The CoE shall submit an Annual Progress Report by no later than end March each year, including the Stage 5 Gate Review Documentation by no later than March 2015 to be reviewed by the CoE Advisory Board.

2012: The annual progress report for 2012 will be presented to the Board on 28 March 2013.

The CoE shall submit a Statement of Compliance by no later than March 2015 referring to Stage 5. *To be submitted in 2015.*

STANDARD OUTPUT TARGETS PER ANNUM IN THE CURRENT STAGE

Total number of students supported50 on average per annum2012:91, including post-doctoral fellows.

Woman students 50% of all students on average per annum 2012: 55% (50 women)

Black students 50% of all students on average per annum 2012: 56% (51 students)

Number of social science students 2 on average per annum 2012: 2

Average duration of submitted Masters degrees (post Honours) 2.5 years at end of stage 2012: 3.5 years

Average duration of submitted PhD degrees (post Masters) 3.5 years at end of stage 2012: 4.2 years

Average duration of submitted PhD degrees (upgraded from Masters) 5 years at end of stage 2012: 4.6 years

Post-doctoral researcher 10% of all students at end of stage 2012: 14%

Each core team member must undertake at least one scientific review per annum on behalf of the NRF (postal peer review process or panel) 2012: 29

Number of patents 1

2012: None

Number of peer reviewed publications 60 on average per annum 2012: 103

Number of peer reviewed publications 1 with an impact rating of 15 on average per annum 2012: 2

Number of peer reviewed publications 10 with an impact rating of 4.0 on average per annum 2012: 31

Number of national conference presentations 20 on average per annum 2012: 41 (no invited, plenary and keynote; 37 oral; 4 poster)

Number of international conference presentation 10 on average per annum 2012: 34 (4 invited, plenary and keynote; 21 oral; 9 poster)

Number of joint venture student training initiatives 20 on average per annum 2012: 27

Number of local conferences organized 1 at end of stage 2012: 1 (Workshop on 'Rapid Response, Early Detection, and Risk Assessment of Invasive Alien Species', Wallenberg Centre, Stellenbosch, South Africa, August 2012).

Number of international conferences organized 1 at end of stage 2012: 1 (Tree Invasion Workshop, Bariloche, Argentina, September 2012).

SPECIAL OUTPUT TARGETS FOR THE CURRENT STAGE

At least one full CoE team activity per annum. 2012: Annual Research Meeting held on 15-16 November (one CTM did not attend).

Successful continuation of Iimbovane outreach project to schools in the WCED region. 2012: 28 participating schools (17 rural/11 urban; 18 full participation/10 subscription).

10 Conclusion

2012 was an exceptionally successful and productive year for the C·I·B in terms of all its Key Performance Areas. The C·I·B is well established internationally as a centre of research excellence in invasion biology, as shown by the increasing interest from around the world to collaborate with C·I·B researchers, invitations to our team members to participate in high-level international initiatives, and the impact of our published research. Interactions with several key partners in South Africa and abroad were strengthened during 2012. Adjustments to the C·I·B's network of core team members, research associates and partners continue to be made to fine-tune and improve the impact of our work on all fronts. The C·I·B's flagship outreach project Iimbovane continues to serve as a model in many respects.

11 Finances

Audited financial statements provided by PriceWaterhouse Coopers (attached).

DST / NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY ANNUAL FINANCIAL STATEMENTS - 31 DECEMBER 2012

ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2012

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

.....

.....2013 DATE

STATEMENT OF FINANCIAL POSITION AT 31 DECEMBER 2012

	Notes	2012 R	2011 R
ASSETS			
NON-CURRENT ASSETS		753 377.45	1 048 787.48
Equipment and vehicles	2	753 377.45	1 048 787.48
CURRENT ASSETS		4 934 968.36	2 517 156.37
Trade and other receivables Stellenbosch University	3 4	256 569.65 4 678 398.71	37 602.62 2 479 553.75
TOTAL ASSETS	=	5 688 345.81	3 565 943.85
EQUITY AND LIABILITIES			
CAPITAL AND RESERVES		5 497 228.07	3 165 081.46
Accumulated funds		5 497 228.07	3 165 081.46
CURRENT LIABILITIES		191 117.74	400 862.39
Trade and other payables	5	191 117.74	400 862.39
TOTAL FUNDS AND LIABILITIES	-	5 688 345.81	3 565 943.85

STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER 2012

	Notes	2012 R	2011 R
Revenue		8 096 985.00	7 767 276.00
Other income		4 661 232.77	5 260 496.48
Operating expenses	7	(10 648 967.61)	(12 728 912.09)
Operating loss		2 109 250.16	298 860.39
Finance income		226 450.36	208 000.12
Finance cost		(3 553.91)	(351.82)
Surplus/(loss) for the year	_	2 332 146.61	506 508.69
Other comprehensive income		-	-
Total comprehensive income/(loss) for the year		2 332 146.61	506 508.69

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 DECEMBER 2012

	2012 R	2011 R
ACCUMULATED FUNDS		
At the beginning of the year	3 165 081.46	2 658 572.77
Total comprehensive income/(loss) for the year	2 332 146.61	506 508.69
At the end of the year	5 497 228.07	3 165 081.46
STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 31 DECEMBER 2012

	2012	2011
	R	R
CASH FLOWS FROM OPERATING ACTIVITIES		
Net surplus/(loss) for the year Adjustment for:	2 332 146.61	506 508.69
Interest received	(226 450 36)	(208 000 12)
Interest paid	3 553.91	351.82
Depreciation	367 871.31	428 463.97
Profit on sale of equipment and vehicles	74 060.26	(62 955.73)
Operating profit/(loss) before working capital adjustments	2 551 181.73	664 368.63
Working capital adjustments	(428 711.68)	112 257.73
Increase in trade and other receivables	(218 967.03)	69 933.23
Increase in trade and other pavables	(209 744.65)	42 324.50
	(/	
Cash generated from operations	2 122 470.05	776 626.36
Interest received	226 450.36	208 000.12
Interest paid	(3 553.91)	(351.82)
NET CASH FLOWS FROM OPERATING ACTIVITIES	2 345 366.50	984 274.66
CASH FLOWS FROM INVESTMENT ACTIVITIES		
Equipment and vehicles purchased	(146 521.54)	(543 713.87)
Proceeds on the sale of fixed assets		63 155.00
Increase in amount owed by Stellenbosch University	(2 198 844.96)	(503 715.79)
NET CASH FLOWS FROM INVESTMENT ACTIVITIES	(2 345 366.50)	(984 274.66)
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		

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2012

1. ACCOUNTING POLICY

BASIS FOR PREPARATION

The centre's financial statements for the year ended 31 December 2012 is the first annual financial statements that comply with IFRS. The centre's transition date is 1 January 2011. In preparing these annual financial statements in accordance with IFRS 1, the centre has elected not to apply any of the optional exemptions. There are no reconciling differences between IFRS and SA GAAP for the centre.

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.

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2012 (continued)

1. ACCOUNTING POLICY (continued)

INCOME RECOGNITION

Income consists mainly of a National Research Foundation grant, the contribution from the Vice-chancellor: Research to the centre 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 2013 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 IFRS 1: First-time Adoption of International Financial Reporting Standards (IFRSs) (1 January 2013) Amendment to IFRS 7 Disclosures – Offsetting Financial Assets and Financial Liabilities (1 January 2013) IFRS 9 Financial Instruments (1 January 2015) IFRS 10 Consolidated Financial Statements (1 January 2013) Amendments to IFRS 10, IFRS 12 and IAS 27 - Investment entities (1 January 2014) IFRS 11 Joint Arrangements (1 January 2013) IFRS 12 Disclosure of Interests in Other Entities (1 January 2013) IFRS 13 Fair Value Measurement (1 January 2013) Amendments to IAS 1 - Presentation of Items of Other Comprehensive Income (1 July 2012) Amendments to IAS 19 Employee Benefits (1 January 2013) Revised IAS 27 Separate Financial Statements (1 January 2013) Revised IAS 28 Investments in Associates and Joint Ventures (1 January 2013) Amendment to IAS 32 Offsetting Financial Assets and Financial Liabilities (1 January 2014) Improvements to IFRSs 2011 (1 January 2013) IFRIC 20 Stripping Costs in the Production Phase of a Surface Mine (1 January 2013)

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.

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2012 (continue

2. EQUIPMENT AND VEHICLES

	Equipment R	Vehicles R	TOTAL R
31 December 2012 Carrying amount at the beginning of the year	711 057.03	337 730.45	1 048 787.48
Cost Accumulated depreciation	2 672 959.92 (1 961 902.89)	432 535.56 (94 805.11)	3 105 495.48 (2 056 708.00)
Additions during the year Transfers	146 521.54	-	146 521.54 -
Cost Accumulated depreciation	276 593.24 (276 593.24)	-	276 593.24 (276 593.24)
Disposals	(74 060.26)	-	(74 060.26)
Cost Accumulated depreciation	(156 280.91) 82 220.65	-	(156 280.91) 82 220.65
Depreciation for the year	(367 871.31)		(367 871.31)
Carrying amount at the end of the year	415 647.00	337 730.45	753 377.45
Cost Accumulated depreciation	2 939 793.79 (2 524 146.79)	432 535.56 (94 805.11)	3 372 329.35 (2 618 951.90)
31 December 2011 Carrying amount at the beginning of the year	582 355.44	351 381.41	933 736.85
Cost Accumulated depreciation	2 330 668.04 (1 748 312.60)	371 822.10 (20 440.69)	2 702 490.14 (1 768 753.29)
Additions during the year	387 400.41	156 313.46	543 713.87
Disposals	(199.27)	-	(199.27)
Cost Accumulated depreciation	(140 708.53) 140 509.26	-	(140 708.53) 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 Accumulated depreciation	2 672 959.92 (1 961 902.89)	432 535.56 (94 805.11)	3 105 495.48 (2 056 708.00)
		2012 R	2011 R
3. TRADE AND OTHER RECEIVABLES			
Trade receivables		254 270.00	35 302.97

Other	2 299.65	2 299.65
	256 569.65	37 602.62
The ageing of these receivables are as follows: Up to 2 months 2 to 6 months	254 270.00	35 302.97 -
	254 270.00	35 302.97

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 2012 was 5.00% (2011: 7.00%). The loan has no fixed terms of repayment.

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2012 (continued)

	2012 R	2011 R
5. TRADE AND OTHER PAYABLES		
Leave pay provision	106 331.74	342 986.30
Other creditors	32 072.40	3 891.09
Provision for audit fees	52 713.60	53 985.00
	191 117.74	400 862.39

6. INCOME TAX

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

7. OPERATING EXPENSES

Operating expenses includes the following disclosable amounts:

Audit fees - audit	52 713.60	53 985.00
Depreciation	367 871.31	428 463.97
Salaries	5 374 618.97	5 708 565.20

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 on-going 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 2012 and 2011, if the interest rate had been 100 basis points higher/lower and all other variables held constant, the centre's profit/(loss) would have increased/decreased as a result of interest received on loans by R46 783.99 (2011: R19 758.38). The other financial instruments are not exposed to interest rate risk.

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2012 (continued)

8. FINANCIAL INSTRUMENTS (continued)

Fair values

At 31 December 2012 and 2011 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	< 1 year	1 - 5 years	> 5 years
	R	cash flows R	R	R	R
Financial liabilities					
31 December 2012					
Trade and other payables	191 117.74	191 117.74	191 117.74	-	-
Net financial liabilities	191 117.74	191 117.74	191 117.74	-	-
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	-	-

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.

DETAIL INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2012

	2012 R	2011 R
INCOME	12 984 668.13	13 235 772.60
National Research Foundation grant	8 096 985.00	7 767 276.00
Other income	4 734 502.26	5 196 662.36
Interest received	226 450.36	208 000.12
Foreign exchange profit	790.77	878.39
Profit on sale of equipment	(74 060.26)	62 955.73
EXPENDITURE	10 652 521.52	12 729 263.91
Operational expenses	5 277 902.55	7 020 698.71
Advertisements	61 745.89	22 214.38
Audit fees - current year	52 713.60	53 985.00
- previous year over provision	(4 719.90)	-
Consumables	57 751.69	91 661.58
Copying and stationery	56 012.54	28 650.73
Depreciation	367 871.31	428 463.97
Entertainment	6 738.90	6 172.41
Interest paid	3 553.91	351.82
Insurance	2 266.11	3 389.48
Levies	111 121.59	150 940.58
Membership and affiliation fees	57 898.65	25 943.30
Non-capitalised books	295.00	3 961.31
Small capital works: not capitalised	38 107.52	20 497.92
Postage, telephone and fax	76 463.98	87 896.54
Safety clothing	4 456.11	3 885.44
Rent paid for facilities	1 700.00	-
Repairs	140 260.36	79 386.13
Software and internet	50 597.67	31 344.26
Sundry expenses	5 202.86	82 774.09
Team member research costs	3 659 748.92	5 204 623.46
Transport and accommodation	418 190.73	528 833.97
Workshops	109 925.11	165 722.34
Personnel expenses	5 374 618.97	5 708 565.20
Salaries	5 374 618.97	5 708 565.20
SURPLUS/(LOSS) FOR THE YEAR	2 332 146.61	506 508.69