C•I•B

DST-NRF Centre of Excellence for Invasion Biology

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Annual Report

2016

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Ingrid Minnaar, final year PhD candidate, collecting aphids for experimental work on harlequin ladybirds (*Harmonia axyridis*)

Executive summary

Reporting period	:	1 January 2016 - 31 December 2016
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

Progress against Key Performance Areas

Research

The C·I·B's research in 2016 addressed a wide range of disciplines, scientific approaches, issues, spatial and temporal scales, and taxa. We published 201 peer-reviewed papers in 112 journals (93% ISI-accredited and 7% in non-ISI listed journals), including contributions in the high-impact journals *Science*, *Nature Communications*, *Biological Reviews*, *New Phytologist*, *Molecular Ecology*, *Global Ecology and Biogeography*, and *Scientific Reports* (all with Impact Factors greater than 5). Nineteen papers appeared in the premier journal in our field, *Biological Invasions*, of which 12 formed part of a special issue on drivers, impacts, mechanisms and adaptation in insect invasions, that grew from a workshop hosted by the C·I·B in Stellenbosch in 2015. Seven contributions appeared in edited books. Core team member John Wilson was the senior author of an important book titled *Detecting and Responding to Alien Plant Incursions* that was published by Cambridge University Press. Our publications covered many of the most pressing issues in invasion ecology internationally and in a South African context, and the full spectrum of focal areas identified in the C·I·B's strategic plan for 2015-2019. Our research addresses fundamental issues related to the biology of invasive species, aspects of invaded ecosystems, invasion processes, and many facets of the human dimension of invasions. The report that follows provides a sample of the research outputs but further details of these and many other publications produced during 2016 are available in the appendix lists and on the C·I·B website.

Education and Training

Seventy-one students (80% from RSA) and 16 post-docs (38% from RSA) were supported by the Centre during 2016. Four of our PhD students graduated and all are employed with partner organizations or are continuing their academic careers. Many of our alumni occupy important positions in a range of sectors including businesses, consultancies, government agencies and NGOs and CBOs. During 2016 we hosted three interns from SANBI and one from NRF. We continued the 3rd-year undergraduate module on Invasion Ecology at Stellenbosch University.

Networking

The C·I·B enjoyed ongoing productive interactions with partner organizations and assisted our key partners with important interactions. We participated in the Sri Lankan Overseas Training Programme on Invasive Species coordinated by the Natural Resources Management Programmes

of the Department of Environmental Affairs. The C·I·B Visiting Fellows programme was a great success in 2016, and we hosted seven fellows from Australia, Kenya, Switzerland and the United States.

Information Brokerage

2016's major information brokerage event was the national conference organised jointly with SANBI's Invasive Species Programme: the 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa. The symposium was designed and themed to support the preparation of the National Status Report on Biological Invasion in South Africa, a key deliverable of the South African National Biodiversity Institute in terms of the 2014 regulations under the National Environmental Management: Biodiversity Act.

At the end of the year we hosted an international workshop on 'Non-native species in urban environments: Patterns, processes, impacts and challenges'. The workshop was coordinated by core team member Dr Mirijam Gaertner of City of Cape Town and was attended by eThekwini municipality and ICLEI - Local Governments for Sustainability – Africa, the international network of cities and urban areas committed to building a sustainable future. The workshop was important for building links between municipal officials and researchers from around the world, and will result in a special issue of the journal *Biological Invasions*.

Service Provision

The C·I·B's major service provision in 2016 was initiating its participation in drafting the National Status Report on Biological Invasions in South Africa. The C·I·B took up a capacity-building and mentorship role in partnership with the South African National Biodiversity Institute by seconding a senior staff member onto the drafting team. Prof. Brian van Wilgen will work with the South African National Biodiversity Institute staff until the end of 2017. C·I·B staff and researchers hold positions as Editors, Associate Editors and members of Editorial Advisory Boards and are frequently called on to review funding proposals and staff appointments from many parts of the world.

What was the gender impact of the C·I·B's work?

Women are 28 % of the core team and 35% of research associate network of the Centre. All of the hub staff are women, and importantly, the all-woman Iimbovane team is a strong role model for inspiring secondary science learners to take up scientific careers. Our student body is 56% female, and 62% of our post-doctoral associates are female. The C·I·B makes a concerted effort to provide an inclusive and friendly yet professional environment where all genders and cultural groups feel comfortable and are able to be productive and grow. These efforts include a range of training events and academic meetings where training takes place. Women consistently perform well in our annual presentation awards (this year five out of six of the winners were women). We have initiated a series of coaching workshops to be started in 2017 which will be open to all new C·I·B students and post-docs; the aim is to improve the level of preparedness of all students entering the C·I·B and make the Centre a more 'student-ready' institution.

Red Flags

Unrest at universities throughout SA in 2016 caused disruption to academic activities and serious damage to South Africa's image internationally as a destination for foreign students, post-docs and collaborators. Uncertainty about the sustainability of the C·I·B is impeding the building of long-term partnerships, but we hope that the up-coming Sustainability Plans will make the future options for the Centre clear to our stakeholders, funders, team and staff. The departure of three key staff from City of Cape Town's Environmental Resource Management Department and restructuring in the invasive species programme there has affected our ability to work with CoCT in the long term. We are re-focusing our relationship with them using different mechanisms.

General Comments

2016 was a successful year during which we consolidated several important relationships, for example with Natural Resources Management Programmes and the South African National Biodiversity Institute, and met all our Service Level Agreement targets. We commenced intensive work on sustainability planning for the post-2019 period and communicated broadly with team members, partners and funders about the desirable and feasible futures.

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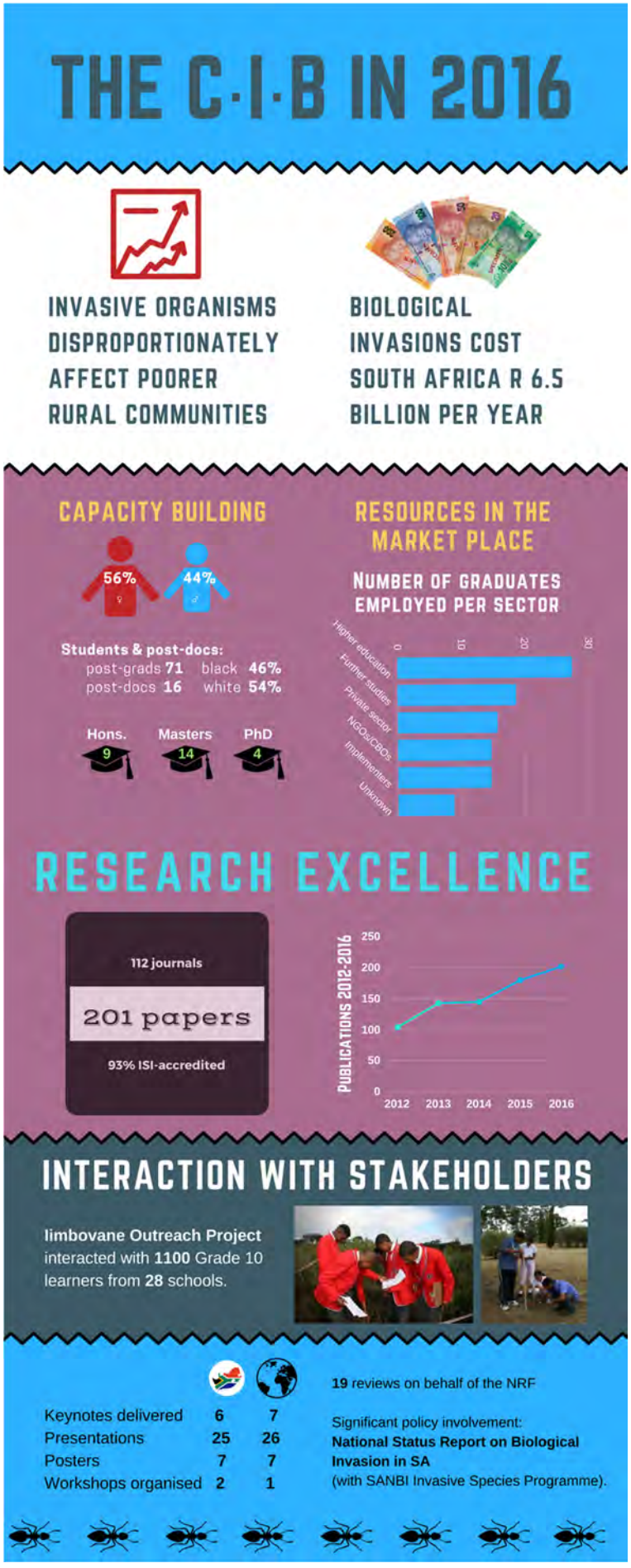

Infographic showing the main achievements of the C·I·B in 2016 according to our Service Level Agreement with the NRF.

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C·I·B
DST-NRF Centre of Excellence for Invasion Biology

Contents

1 Scientific Research

1.1 Objectives

The C·I·B's research aims to reduce the rates and biodiversity impacts of biological invasions, by understanding how these can be reduced and remediated through appropriate policy interventions, and how interactions among global change drivers, especially climate change and biological invasions, might further influence the impacts of biological invasions and alter policy advice.

Therefore, our projects and integrated programmes of research target all aspects of the phenomenon of biological invasions, all taxonomic groups and all ecosystems (Figure 1). Better understanding of invasion patterns and processes is required, and options for management and remediation need to be explored. We further realize that each stage in the invasion process (pre-introduction; initial incursion; expansion; and dominance) demands special tools, insights and types of study.

Besides the aspects attached specifically to the aforementioned compartments, the C·I·B proposes to undertake work in several overarching themes: Biological foundations; model systems; human dimensions; basic inventories; modelling capacities; and policy formulation and risk assessment. This suite of themes provides the scope for cutting-edge work in invasion science, while providing opportunities to draw in students from diverse biological fields (from fundamental to applied) and many other disciplines.

1.2 Progress

Short-term strategic 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. Molecular methods as a tool in invasion science are a cross-cutting theme, as they are becoming increasingly widely used to identify the provenance of introduced species and for uncovering many aspects of the invasion process. The ability to distinguish apparently similar species at the cellular level is a fundamental component of the C·I·B's research tool box, and substantially contributes to many of the research projects detailed below. Further details of many research projects are given on the C·I·B's web site (http://academic.sun.ac.za/cib/). The projects summarized below give a flavour of the wide range of disciplines, taxa, spatial and temporal scales, and scientific approaches in the C·I·B's research during 2016 (Figure 1).

Research focussed on many of the most pressing issues in invasion ecology and the full spectrum of focus areas identified in the C·I·B's strategic plan. Our research is addressing fundamental issues related to the biology of invasive species, aspects of invaded ecosystems, invasion processes, and many facets of the human dimensions of invasions.

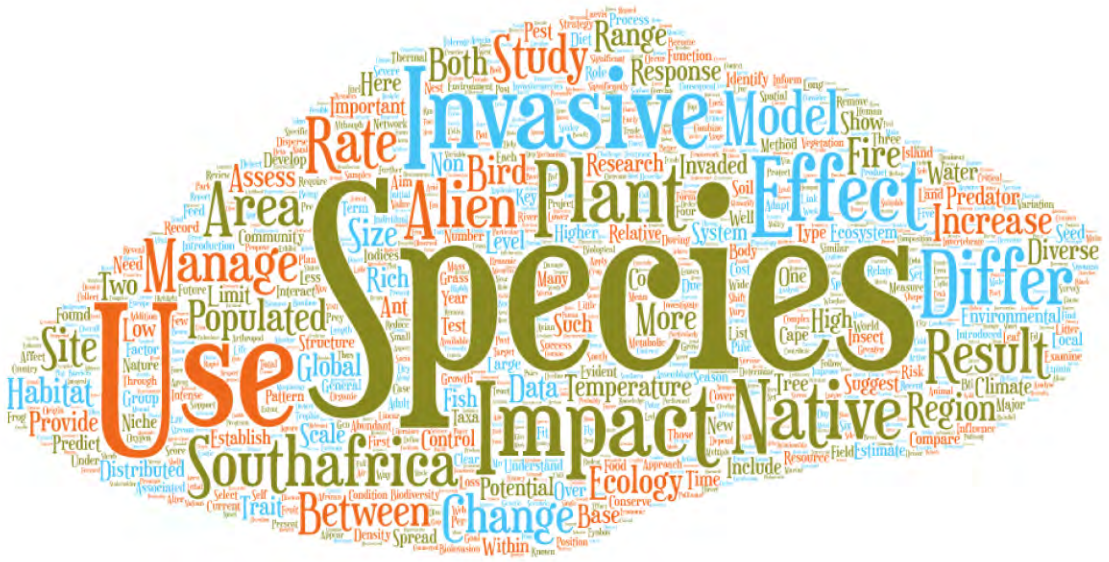


Figure 1. Word cloud reflecting the titles and abstracts of C·I·B publications in 2016

1.2.1 Long-term collaborative research

Long-term change in arthropod assemblages

The C·I·B manages three long-term monitoring transects which gather data on invertebrate communities in relation to altitude, aspect, climate, vegetation and other biological variables. The system is summarised in Table 1. The plan is to analyse the long-term data from the three transects separately and together to advance our understanding of the relationship between biodiversity and climate using hyper-diverse insect groups such as ants. As the long-term data sets reach maturity, the analysis and publication of this work will be an ongoing collaboration between the C·I·B Core Team Members and the Universities of Monash (Australia) and Oxford (UK).

Table 1: Summary of the C·I·B's long-term monitoring of insect assemblages

Type of sampling	No. of sites	Replicates per site	Traps per replicate	Aspect	Sampling periods	Elevation range (m amsl)	Arthropod groups sampled
Cederberg (2002-2014):							
climate; biological	17	4	10	W	Mar, Sep	0-1926	Ants, carabid beetles and spiders*
Sani Pass (2006-):							
climate; biological	8	4	10	E	Jan, Sep	900-3000	Ants
Soutpansberg (2009-):							
climate; biological	11	4	10	N, S	Jan, Sep	800-1700	Ants, beetles and spiders*

* spider by-catch is donated to the South African National Survey of Arachnida.

SPIDER DIVERSITY IN OUR MOUNTAINS

A study by C·I·B Core Team Member Stefan Foord and co-author Ansie Dippenaar-Schoeman (Agricultural Research Council) in the Cederberg mountains of the Western Cape points to the remarkable ability of spiders to respond to changes in the environment.

Figure 2. Spiders in the genus *Ammoxenus* were very abundant along the Cederberg transect. Species in this genus are specialized to eat termites. (Image: Peter Webb)

Anyone who has taken a hike in the mountains will have noticed that is gets warmer as one walks downhill. The different temperature zones across a mountain range are home to a variety of plants and animals — each adapted to live at a specific temperature. However, in the light of future climate change, scientists need to understand how changes in temperature will affect species diversity. Foord and Dippenaar-Schoeman (2016; *J. Biogeogr*. 43: 2354–2365) examined how the diversity of spiders changes across a mountain range.

Data for this study were collected with pitfall traps over 6 years (2004–2009) from 17 sites set out at different heights. A total of 10 094 spiders from 178 species were caught during the 6-year study. They found that 65% of the spider species in this study are endemic to South Africa and that four of the five most abundant species occur nowhere else but the Western Cape province.

"The study suggests that spiders are good indicators of change, partly because of their excellent ability to colonize new areas and because of their sensitivity to changes in temperature," says Stefan Foord. He adds, "Future research will focus on unravelling the role of another important driver of change in spider communities - habitat structure."

Interestingly, the majority of the most abundant and widely distributed species in this study were endemic to the region. This contrasts with what other studies have found for the rest of the country, where endemics had restricted distributions and had very low abundances.

"Levels of spider endemicity in this study are comparable to that of the plants of the fynbos biome and four of the five most abundant species were endemic to the Western Cape" said co-author Ansie Dippenaar-Schoeman, "the study uncovered several species new to science and ten have already been described."

1.2.2 Short-term research

Biodiversity foundations

Recognizing the significance of the foundational aspects of biology and the social sciences within the context of invasion biology, and the fact that human activities more generally are not ontologically separable from other natural processes, the C·I·B has undertaken much foundational

work over its lifespan. Such work has also been essential to draw in students and collaborators who are particularly interested in 'the workings of nature' rather than on particular framings of biological invasions.

DEFINING THE INVASIVENESS AND INVISIBILITY IN ECOLOGICAL NETWORKS

A study by a group of researchers, led by C·I·B Core Team Member Cang Hui, proposed a framework to explain why some alien species are so successful in invading the new areas, whereas others are much less successful.

The ability of an introduced organism to become invasive and the impacts of the invasion depend on the potential of the species itself (invasiveness) and on the susceptibility of the ecosystem they invade (invasibility). However, the two concepts are not clearly defined in a common framework.

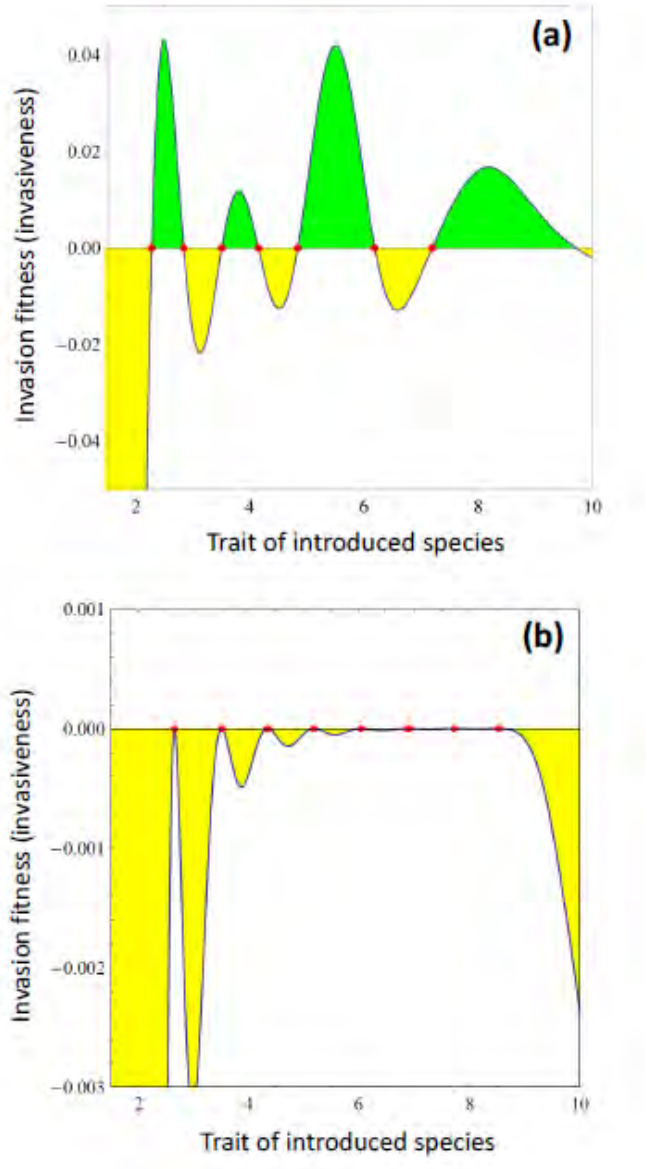


Figure 3. Invasion fitness of an introduced species as a function of its trait value relative to the trait values of the resident species in the ecological networks. Red dots indicate the trait values of native resident species. (a) A randomly generated network at its ecological equilibrium. (b) A saturated assembly is defined as the recipient network with zero invasibility. (From: Hui *et al.* 2016; *Biol. Invasions* 18:971–983).

"Information on invasiveness and invasibility can be useful for the prevention and management of invasions by alien species, and can play a crucial role in the conservation of endemic biodiversity and ecosystem services" says Pietro Landi, co-author of the paper.

This paper formed part of a special issue of the journal *Biological Invasions* which was the main product of a C·I·B-funded workshop on *Drivers, impacts, mechanisms and adaptation in insect invasions* in November 2014.

Hui *et al*. (2016; *Biol. Invasions* 18:971–983) used invasion fitness as a common framework for their definition. The invasion fitness of a species is a measure of the invading potential of a species and depends both on the phenotypic traits of the invading species and those of the species that exist in the ecosystem they invade (Figure 3). Phenotypic traits are observable traits for example body size, competitive ability, life-history and foraging strategies, etc. Invasiveness and invisibility are not easy measure or quantify. However, they are shown to be correlated with the stability and structure properties of the invaded ecosystem. Such metrics are easily computed from the interaction network of the invaded ecosystem, thus providing an estimate of invasiveness and invasibility.

The paper demonstrates the usefulness of the framework using both a theoretical model of a food-web ecosystem and observed interaction networks before and after the invasion of the harlequin ladybird (*Harmonia axyridis*) in agricultural and forest landscapes.

FOOD USE OF AN INVASIVE BARNACLE SUGGESTS POTENTIAL FOR SPREAD

Many invasive species are capable of using resources better than native species in their invaded ranges. If this is the case for the invasive acorn barnacle (*Balanus glandula*; Figure 4) in South Africa, it could have important implications for future spread of the species which is already the dominant barnacle on the West Coast and has recently invaded along the southern coast. The species has important impacts in invaded intertidal communities.

Research on this species was undertake by C·I·B-funded student Haley Pope, C·I·B Core Team Member Tammy Robinson, and C·I·B post-doctoral researcher Mhairi Alexander. To compare the food uptake between the invader and the native white dwarf barnacle, *Notomegabalanus algicola*, filtration and feeding behaviour were measured under different water temperatures and food concentrations that mimic the two invaded coasts.

Figure 4: The study species, the invasive acorn barnacle (*Balanus glandula*) (Image: Haley Pope)

Results showed that the acorn barnacle demonstrated a greater resource use than the native species, regardless of water temperature or food concentration (Pope *et al*. 2016; *J. Exp. Marine Biol. Ecol*. 479: 54-59). This finding indicates that the invasive barnacles have an advantage under both West and southern coast conditions; this may facilitate their further spread along the newly invaded southern coast.

"Our findings were surprising. We were not expecting this temperate barnacle species to display greater resource use under conditions mimicking the warmer, less productive southern coast,"

explains Haley Pope. "It was interesting to see that the invader exhibited a higher relative food uptake than the native barnacle, a species normally found along the southern coast. This gives credence to the invasive nature of the acorn barnacle in South Africa and suggests that it is a species that should be watched into the future."

Continual monitoring of this invasive barnacle is vital to determine whether the species will become established along the southern coast and if so, what impacts it may have on the intertidal community.

IDENTIFYING A SUCCESSFUL INVADER IN MUTUALISTIC COMMUNITIES

Research by C·I·B PhD graduate Dr Ony Minoarivelo and C·I·B Core Team Member Cang Hui explored the features of alien species and invaded ecosystems that may influence the success of alien species. They used a model to predict the success and impact of invasions in mutualistic systems (Minoarivelo & Hui 2016; *Ecol. Evol*. 6: 4981–4996) (Figure 5).

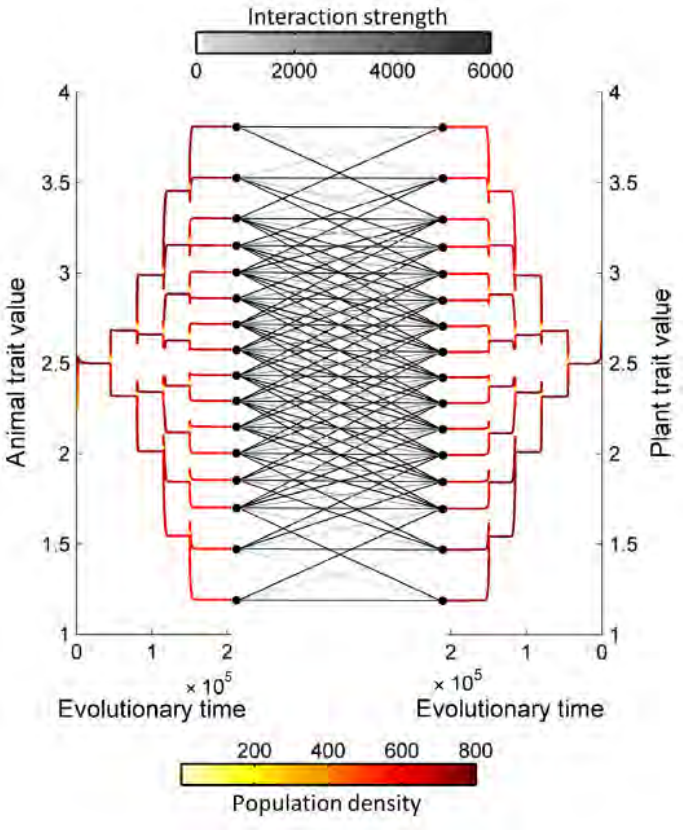


Figure 5: Evolutionary dynamics of a mutualistic network. The trait dynamics preinvasion is represented as two evolutionary trees and its associated interaction network represented as a bipartite graph (From: Minoarivelo & Hui 2016; *Ecol. Evol*. 6: 4981–4996).

Mutualistic systems are communities where species have interactions that are beneficial for both parties, for example insect pollinators and the plants they pollinate. In these systems, alien species do not always have a negative impact and their presence might benefit the invaded community.

The study made three important findings. First, when the phenotypic trait of the alien species, such as the proboscis length of an insect pollinator, differs substantially from traits of the native species,

the alien species is more likely to become invasive. Second, to invade further, the invader needs to establish interactions with as many partner species as does the average native species. Finally, the study showed that the most invasive species are not always the ones that cause the biggest impact. This highlights the need to differentiate highly invasive species from those with big impacts before deciding on how to manage them. *"Invasive species should only be targeted if their negative impacts outweigh their positive effects,"* explains Dr Minoarivelo.

Depending on the species interaction inside the community, some mutualistic communities might collapse quickly after the loss of only few of their species. Surprisingly, such communities are very resistant to the invasion of new species. Hence, Dr Minoarivelo emphasizes *"there is a need to use the appropriate measure when quantifying the stability of an ecological community. Results might depend on which measure has been used. Stability measurement should not be interpreted outside the initial context in which the drivers of change (example species loss or species invasion) have been defined."*

Model systems for understanding invasions and impacts and developing sustainable management strategies

Several key groups of organisms and settings (Australian acacias, invasive birds, the harlequin ladybird, *Xenopus laevis* and environments such as urban areas and agricultural contexts) have, for various reasons, been selected as model groups or systems for gaining important insights on the full range of challenges and management options associated with introduced species in South Africa.

Acacias as model systems for understanding invasions and impacts

Invasive acacias have commercial and other benefits in certain contexts, but increasing negative impacts in others. Furthermore, they have substantial influence (positive and negative, depending on geographical and socio-political context) on ecosystem services, and much value as a natural experiment of widespread introductions and plantings. This allows useful lessons to be learnt from other regions of the world. Australian acacias have featured prominently in research undertaken at the C·I·B over the past decade.

THE SPECIALISED NATURE OF LEGUME-RHIZOBIUM NETWORKS IN THE FACE OF ACACIA INVASIONS

High levels of specialisation characterise the relationships between native and invasive legumes and their mutualistic bacteria called rhizobia. This was the main finding of a paper by C·I·B Core Team Member Jaco Le Roux and colleagues that describes how plant-microbial networks are affected by invasive alien species (Le Roux *et al*. 2016; *AoB PLANTS* 8: plw038).

Mutualistic relationships exist when two organisms of different species 'work together' and both benefit from the relationship. For example, legumes (plants from the family Fabaceae) form mutualistic networks with bacteria in the soil called rhizobia. Rhizobia can fix gaseous nitrogen from the atmosphere turning it into a form of nitrogen that can be used by the legumes. In return, the legumes provide the rhizobia with carbon.

How well these relationships work can determine how successful an invasive species can be in a new area. It is therefore important to understand the networks between rhizobia and legumes. Jaco Le Roux and co-workers looked at legume-rhizobium networks and explored how they respond to invasions of Australian acacias in South Africa.

They found that the hypotheses for mutualistic networks above the ground (e.g. pollination of plants by birds) may not hold for their counterparts in the soil. When assessing the legume-rhizobium relationships in sites invaded by acacias and in sites without acacias, they found that the relationships are highly specialised (Figure 6).

"This means that invasive acacias do not infiltrate existing relationships between native legumes and their associated rhizobia, but rather form unique and novel relationships, possibly because the associated rhizobia have been co-introduced with acacias to South Africa" explains Prof. Le Roux.

These findings are in stark contrast to the expectation from aboveground mutualistic interaction webs and their responses to invasive species; that generalised mutualist requirements facilitate infiltration of invasive species into existing native species interaction webs.

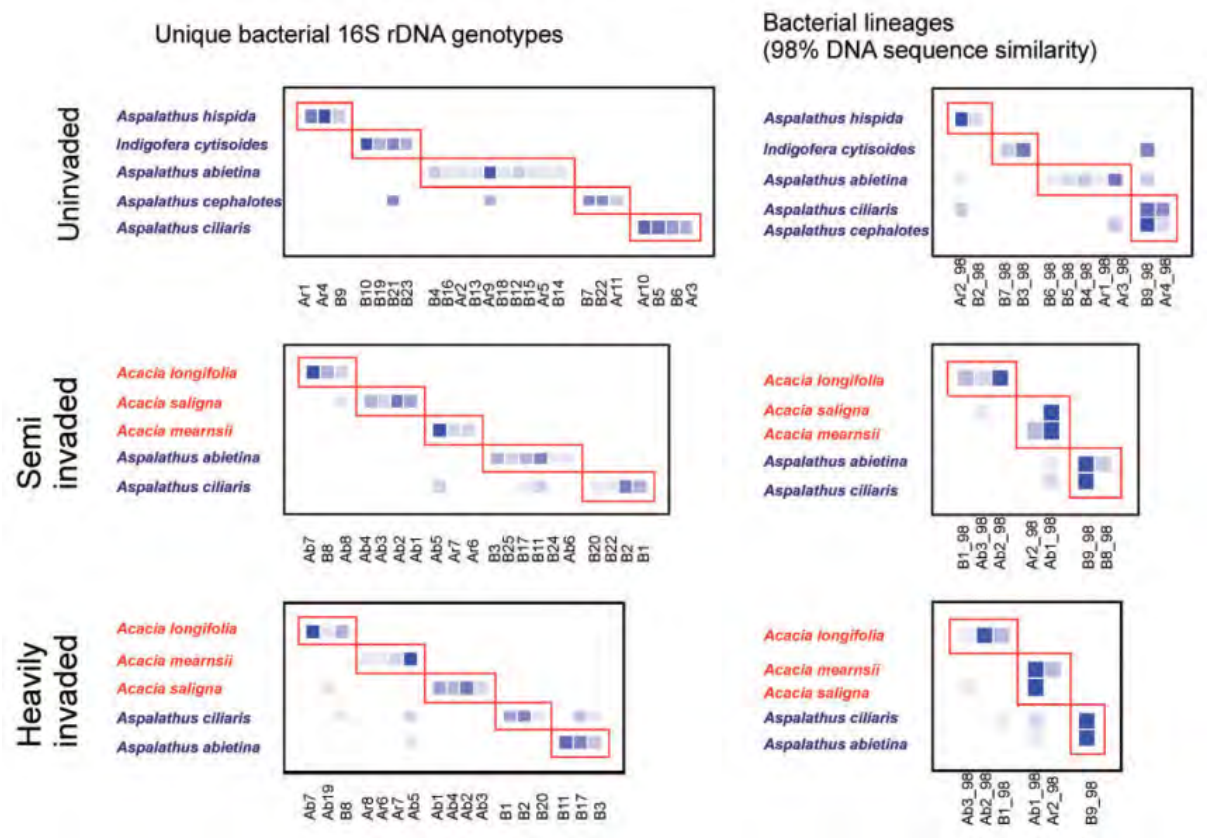


Figure 6: Networks representing legume–rhizobium interactions across a gradient of acacia invasion (uninvaded, semi invaded and heavily invaded sites) for bacterial taxa defined as individual genotypes and at the 98% 16S rDNA sequence similarity levels (From: Le Roux *et al.* 2016; *AoB PLANTS* 8: plw038).

The acacias also appear to change the composition of rhizobia which means that native legumes interact with a different suite of rhizobia in invaded areas compared to uninvaded areas.

Prof. Le Roux commented on the relevance of this study: "In a broader sense, our paper illustrates a previously overlooked way in which biodiversity is impacted by biological invasions, with potentially important implications for ecosystem management and restoration of the services they provide. Our paper sets the stage for important and much needed future research efforts to better understand how plant-microbial interactions impacts on the structure plant communities and how these may react to forces of global change."

Invasive birds as a model group

NEW APPROACHES FOR COMPILING LISTS OF THE MOST IMPORTANT INVASIVE BIRDS

Several schemes exist for categorizing invasive species regionally or globally according to the severity of their impacts. Such schemes are potentially useful for planning and monitoring management operations, for example as an input to prioritizing species for management attention. Lists of harmful species, such as the IUCN Invasive Species Specialist Group's '100 of the worst' lists, are also important for educating the public about invasive species and the impacts they can cause. However, it has been argued that such lists are of questionable value, as the selection of species for inclusion on lists appears to be arbitrary and not based on transparent criteria.

Research by C·I·B Core Team Members Dr Sabrina Kumschick and Prof. Dave Richardson and C·I·B associate Prof. Tim Blackburn investigated whether the birds on the ISSG's '100 of the worst' list are indeed the most influential invasive species (Figure 7). Their paper suggests a new approach for alien species listing according to their impacts, using a semi-quantitative method (Kumschick *et al*. 2016; *Bird Conserv. Int*. 26: 154 – 163).

Figure 7: The Canada goose (*Branta canadensis*) achieved the highest impact score of all birds assessed to date (Image: Wikipedia Commons)

They researched the impacts of the birds listed on two of the most frequent used lists, namely the IUCN ISSG's '100 of the World's Worst Invasive Alien Species' and the '100 of the Worst' list of invaders in Europe. Using a generic impact scoring system, they compared the magnitude of impacts between species and the mechanisms through which the impacts were caused. This includes for example competition for food and nesting sites, predation on native species, and socioeconomic impacts such as feeding on agricultural crops and disease transmission to humans.

The study showed that the two lists represent some of the worst invasive birds, and the most important mechanisms causing impacts, with some overlap between the species on the IUCN list. "As a way forward, we suggest selecting the worst alien species according to a transparent system or guidelines, and backing up such a selection with quantitative data. This would not affect the educational purpose of the lists, but could lead to a more balanced representation of the types of impacts that alien species can cause," explains Dr Kumschick.

Ladybirds as a model group

FIRST RECORD OF A PARASITIC FUNGUS ON LADYBIRDS IN SOUTH AFRICA

The first detection of the parasitic fungus *Hesperomyces virescens* on ladybirds (coccinellid beetles) in South Africa was made by an international team of researchers including C·I·B-affiliated scientists and collaborators from Harvard University in the USA. The team examined the occurrence of *H. virescens* on invasive and native ladybirds around Stellenbosch, Western Cape Province, South Africa (Haelewaters *et al*. 2016; *Parasite* 23: 5).

Hesperomyces virescens, a fungus that infects adult ladybirds, can be identified by yellow fruiting bodies that the fungus produces from spores (Figure 8). These spores are spread from one ladybird to another through direct contact. The spores are mostly found on specific places such as the back of ladybirds suggesting that it spreads during mating or when ladybirds intermingle while forming groups to keep warm in winter.

Figure 8: Yellow fruiting bodies (indicated by the arrow) on the dorsal end of an invasive harlequin ladybird, *Harmonia axyridis* (Image: Ingrid A. Minnaar)

Ladybirds collected in Stellenbosch between 2013 and 2015 were screened for these fungal fruiting bodies, and DNA sequencing techniques were used to identify the fungus. The researchers reported the first records of the fungus on the invasive harlequin ladybird, *Harmonia axyridis*, and on the

native ladybird, *Cheilomenes propinqua*. The findings suggest that the main host for this fungus in South Africa is the invasive ladybird *Harmonia axyridis*. Native to Asia, this beetle has spread to all continents, except Antarctica. Its aggressive nature and competition with other ladybirds has led to the decline of native ladybird species in many regions of the world.

"It is not yet known whether the fungus negatively affects its hosts or whether its spread is facilitated by the invasive ladybird *Harmonia axyridis*. If the fungus has harmful effects on native ladybirds, these new infestations could add to the decline of native ladybirds in South Africa. On the other hand, if the fungus mainly impacts *Harmonia axyridis*, it could potentially be used to control this invasive ladybird" says Ingrid Minnaar, C·I·B-funded PhD student and co-author of the paper.

***Xenopus laevis*: a globally significant invader**

FRENCH PLATANNAS ORIGINATED FROM MANY SITES ALL OVER SOUTH AFRICA

African clawed frogs (*Xenopus laevis*), also known as platannas (Figure 9), which are native to South Africa but invasive on four continents are one of the most highly impacting invasive amphibians, second only to Cane toads (*Rhinella marina*). A new study found that their invasions had both ecological and social impacts (Measey *et al.* 2016; *Diversity & Distributions* 22: 970-981).

Knowing the origin of these invasive populations is useful in developing appropriate management strategies. This is particularly important when an invasive species has been introduced from a large mega-diverse region, like South Africa, which spans temperate and tropical climates.

Research involving C·I·B-affiliated staff and students was done to determine the source regions for introductions that generated invasive populations of platannas in France. This work showed that the French populations originated from multiple localities across South Africa (De Busschere *et al*. 2016; *PeerJ* 4:e1659).

Data from DNA of invasive African clawed frogs in France and Portugal were compared to DNA from native populations in their distribution in southern Africa. Surprisingly, the French invasion is comprised of DNA from two different populations of African clawed frogs, suggesting that these animals had been brought to France from multiple collection sites all over the country. In all other invasive populations where this has been studied, the invasions derive from the southwestern Cape which ties in with historical evidence.

This new evidence suggests that the success of platannas in France is probably at least partly related to their large genetic diversity which could provide them with an advantage. However, invasive populations do not necessarily rely on high genetic diversity in order to be successful, as shown with other invasive populations of African clawed frogs in Chile and Sicily.

The European team is continuing to investigate the invasive potential of French and Portuguese populations in a collaboration funded by the European Union: INVAXEN.

"The genetic diversity of platannas in France is greater than any one population in South Africa" said C·I·B Core Team Member John Measey. "The invasive population may have a greater genetic basis on which to invade a larger area of Europe."

Figure 9: African clawed frogs (*Xenopus laevis*), also known as platannas, are native to South Africa but are invasive in many parts of the world (Image: John Measey)

Invasions in urban areas

THE C·I·B AND THE CITY OF CAPE TOWN COLLABORATE TO DEFINE NEW APPROACH FOR TACKLING INVASIVE SPECIES IN CITIES

Cities are hotspots for biological invasions. High densities of people, transport linkages for example airports and harbours, and changed habitats facilitate the introduction and spread of invasive species. Managing invasive species in cities is very challenging, partly because of the large numbers of stakeholders with diverse and sometimes conflicting views.

Until now, managers in cities have managed invasive species using approaches developed for rural areas, despite the different socio-environmental conditions in cities. *"Managers of invasive species in cities need a framework for making decisions on how to best deal with individual species in a way that is acceptable and can deliver effective control"*, says C·I·B core member Mirijam Gaertner.

A collaboration between C·I·B researchers and managers from the City of Cape Town's Green Jobs Unit resulted in the development of a framework specifically to help managers manage invasive species in cities. The framework was published in a paper by C·I·B Core Team Members Mirijam Gaertner, Dave Richardson and Brian van Wilgen, C·I·B research fellow Brendon Larson, C·I·B associates Patricia Holmes and Ulrike Irlich, and Louise Stafford from the Green Jobs Programme.

The paper suggests selecting species according to their potential for causing impact (now and in the future) and the perceived value of the species. Depending on these factors, species can be grouped into three categories namely: (1) tolerance, (2) active engagement, (3) control priority (Gaertner *et al*. 2016; *Landscape Urb. Plan*. 151: 1–9; Figure 10).

The 'tolerance' category is for species with high benefit and low impact for example, Karri gum (*Eucalyptus diversicolor*). Karri gum occurs in plantations in Table Mountain National Park that are popular with hikers, cyclists and tree enthusiasts. Perceived benefits are therefore high. Although these gum trees impact water resources, they are not highly invasive (therefore a low impact).

The 'Active engagement' category is for species that hold benefits but have negative impacts, for example, Monterey pine (*Pinus radiata*). Monterey pine are popular with hikers, cyclists and tree enthusiasts (high perceived benefit), but they are highly invasive and threaten the biodiversity of Table Mountain National Park (high impact). The 'control priority' category deals with species that have high impacts and low benefits, for example, most Australian Acacia species and some aquatic plant species, such as water hyacinth (*Eichhornia crassipes*), has no benefits, is highly invasive and has major negative impacts

The study shows that stakeholder perceptions need to be given clear consideration and that management frameworks should allow for the acceptance of some invasive species.
"We may need to tolerate some invasive species for a combination of social and pragmatic reasons, however, we should look at ways to minimise potential negative effects" says Gaertner. She adds "The framework gives managers a much needed novel approach to tackling invasive species management in cities."

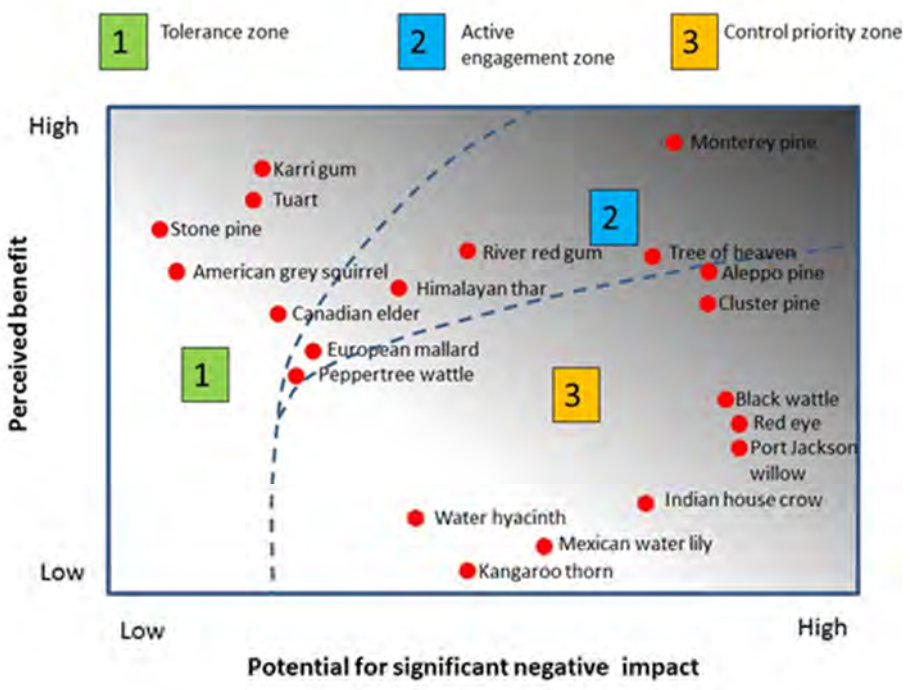


Figure 10: Proposed categorization of invasive species according to perceived benefits and potential negative effects (invasiveness, ecosystem and social impacts). Three management approaches are recognized: (1) tolerance; (2) active engagement; and (3) control priority. Shading reflects the probability of conflicts of interest (light grey to dark grey = low to high probability). (From: Gaertner *et al.* 2016; *Landscape Urb. Plan.* 151: 1–9)

Agricultural pest insects as models for invasion science

REDUCING UNCERTAINTY IN INVASION THREATS OF AGRICULTURAL CROP PESTS: LURKING DANGER OF NATAL FRUIT FLY?

How do we know whether a pest insect is likely to become invasive and a threat in the future? When and where should we take action to prevent further invasion? These are just two of the questions that a team of C·I·B researchers tackled with reference to the Natal fruit fly (*Ceratitis rosa*), which is a major agricultural pest in Africa.

Research undertaken by C·I·B Core Team Member John Terblanche and co-workers warns of the looming threat of the lesser-known Natal Fruit Fly, *Ceratitis rosa* (Tephritidae) outside of its native range (Karsten *et al*. 2016; Molecular Ecol. 25: 3019–3032).The fly is currently restricted to south-eastern Africa, but it appears to have traits that may predispose it to being highly invasive.

Figure 11: A male specimen of the Natal fruit fly (*Ceratitis rosa* Karsch), the morphotype R2 from South Africa (*Photo credit: AP Malan*)

Previous work showed that, across Africa, the Natal fruit fly is genetically structured into two clusters (R1 and R2; see Figure 11), with these two clusters occurring sympatrically (when they exist in the same geographic area and regularly encounter one another) in the north of South Africa. The spatial distribution of these genotypic clusters within South Africa was previously unexamined despite their importance for understanding the pest's invasion potential.

Hundreds of South African Natal fruit flies were collected, measured and genotyped to investigate patterns of population structure and determine connectedness of pest-occupied sites. Surprisingly, the team was unable to detect any signals of differences between the populations. Furthermore, the fly populations were estimated to be extremely large, with only one morphological type (morphotype R2) within South Africa. The absence of the R1 morphotype at sites where it was previously found, may be a consequence of differences in thermal niches between the two morphotypes. A novel analysis of the genetics over long timescales also indicates the populations are presently expanding.

Results from this work suggest a high invasion potential of the Natal fruit fly unless there is urgent intervention and management action. Senior author Dr Minette Karsten explains, "*The immediate implications of this research for management are two-fold. That area-wide pest management should be undertaken on a countrywide scale - a scale much larger than is typically the case. And that careful border control, including the process of fruit inspections, quarantine and interceptions, is critical for the prevention of further invasions.*"

1.2.3 Detection, demonstration, responses and remediation

A NEW TOOL FOR COMPARING IMPACTS OF ALIEN SPECIES

Alien species have different impacts, and setting priorities for their management is a challenge. Often such decisions are based on the magnitude of impacts, and tools are needed to allow managers to compare the impacts of different alien species in an objective and transparent way.

C·I·B Core Team Member Sabrina Kumschick and C·I·B associate Petr Pyšek, together with collaborators from Europe, developed a tool for quantify the impacts of alien species (Nentwig *et al*. 2016; *Environm. Monit. Assess*. 188:315). The tool, called the *Generic Impact Scoring System* (GISS), considers a variety environmental and socio-economic impact and is based on published evidence of impact.

The GISS consists of 12 categories of impacts that invaders have on ecosystems and species, such as competition, hybridisation, predation (which are all environmental impacts), and impacts on agriculture, fisheries and human health (which are termed socio-economic impacts). In each category, impact scores from zero (no impact) to five (the highest impact) are possible (Table 2). The GISS also includes scenarios that describe the impact levels in more detail to assure objective scoring and consistency between different assessors.

Table 2: Definition of the impact levels used in the Generic Impact Scoring System (From: Nentwig *et al*. 2016; *Environm. Monit. Assess*. 188:315)

Impact level	Impact description
0	No data available, no impacts known, not detectable or not applicable
1	Minor impacts, only locally, only on common species, negligible economic loss
2	Minor impacts, more widespread, also on rarer species, minor economic loss
3	Medium impacts, large-scale, several species concerned, relevant decline, relevant ecosystem modifications, medium economic loss
4	Major impact with high damage, major changes in ecosystem functions, decrease of species, major economic loss
5	Major large-scale impact with high damage and complete destruction, threat to species including local extinctions, high economic costs

The maximum impact in each category shows what kind of impacts the respective alien species can cause. The sums of impacts between all categories can pinpoint species which have been the most damaging in the past and which should be monitored to prevent further damage.

The GISS also allows for comparison of diverse metrics of impact, like changes to fire regimes, predation on native species, and damage to agriculture and between species and higher taxa. "The GISS further allows us to pinpoint the worst invaders which can improve prevention in areas where they are not yet present" explains Dr Sabrina Kumschick.

The GISS also enables the comparison of impacts between regions, and can be used to link traits with the most damaging species to aid impact prediction. According to Dr Kumschick *"the GISS is broadly applicable and objective, and its use simple and straightforward, which makes it a useful tool not only to study scientific questions, but also for managers of alien species, policy and regulation. We now finally published concise guidelines for its use."*

IDENTIFYING AND CATEGORISING ENVIRONMENTAL IMPACTS OF ALIEN SPECIES

A new protocol for identifying and categorising the environmental impacts of alien species is needed to help invasion biologists to complete a global stocktaking of the environmental impacts of all known alien species by 2020. A study undertaken by C·I·B affiliates as part of the research project on developing the Environmental Impact Classification for Alien Taxa (EICAT) made an important contribution in this area by assessing the environmental impacts of alien birds.

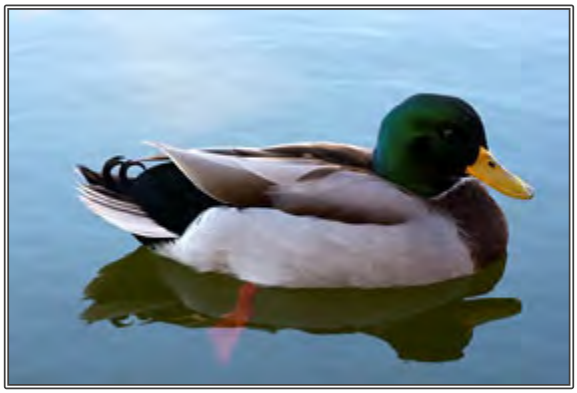


Figure 12: The mallard duck (*Anas platyrhynchos*) has a massive impact through hybridisation.
(Image: By WPPilot - Own work, CC BY-SA 4.0)

The study, conducted by senior author Dr Thomas Evans of University College London with C·I·B Core Team Member Sabrina Kumschick and Research Associate Tim Blackburn, used the EICAT protocol on data from 415 alien bird species worldwide (Figure 12).

The EICAT protocol has been developed to help invasion biologists identify and categorise the magnitude and types of impacts associated with alien species but to also allow the comparison of impacts of alien species across different regions and groups. The study categorised alien birds on the basis of the severity and type of their environmental impacts (Evans *et al*. 2016; *Divers. Distrib*. 22: 919–931). Most impacts were categorised in the lower ranks as either Minimal Concern (MC) or Minor (MN), although 37 bird species had moderate (MO) impacts or above, causing declines in the populations of native species (Figure 13).

The research also showed that alien birds primarily impact the environment through competition, predation, hybridisation and frugivory (fruit-eating birds which caused the spread of alien plants). Impact data were found for only around 30% of alien bird species worldwide, with the rest categorised as Data Deficient (DD).

The International Union for the Conservation of Nature (IUCN) may adopt EICAT as their formal protocol for classifying the impacts of alien species. If this happens, EICAT assessments for all known alien species worldwide should be completed and peer reviewed by 2020, in-line with the requirements stipulated under Aichi Target 9 of the Convention on Biological Diversity (CBD) and Target 5 of the EU 2020 Biodiversity Strategy.

"The study demonstrates that EICAT can be used to categorise and quantify the impacts of alien species for a complete taxonomic class. It also indicates that there is much to learn about the impacts of aliens, as we have no information on the environmental impacts of most species, even in a well-studied group like birds," says Dr Evans.

He adds that, "this is perhaps one of the key benefits of EICAT — by facilitating a global stocktake of the impacts of alien taxa, EICAT directs attention not only to the most damaging alien species, but also to those species, taxa, locations or impact mechanisms for which we do not have sufficient information, from which to make informed management decisions to mitigate the impacts of alien taxa."

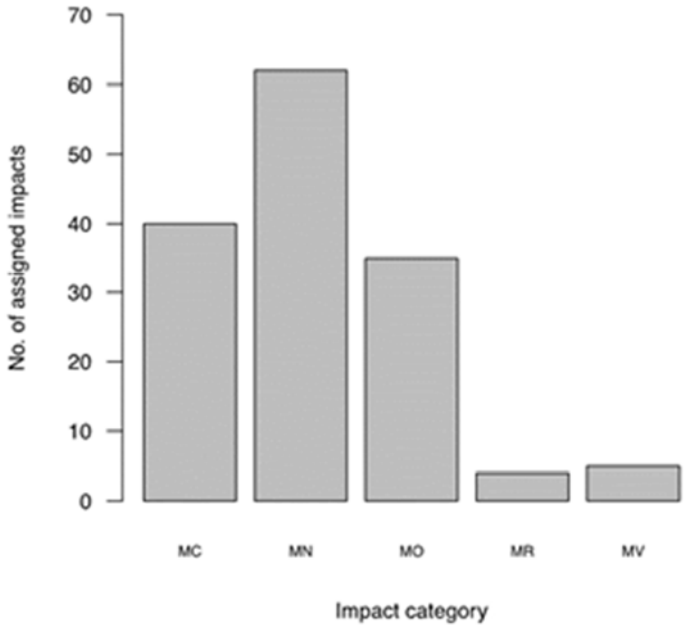


Figure 13: The number of alien bird impacts assigned to each EICAT impact category. A further 296 species were Data Deficient (DD). MC = Minimal Concern; MN = Minor; MO = Moderate; MR = Major; MV = Massive (From: Evans *et al.*, 2016; *Divers. Distrib*. 22: 919–931).

LACK OF HUMAN-ASSISTED SPREAD MEANS KUDZU VINE CAN BE ERADICATED FROM SOUTH AFRICA

A study by C·I·B associate Sjirk and researchers from the C·I·B, SANBI's Invasive Species Programme and the University of Cape Town, highlighted the importance of human activities in the spread of some of the most notorious plant invaders (Geerts *et al*. 2016; *Biol. Invasions* 18: 3119–3126). The study was the first detailed study of Kudzu vine (*Pueraria montana* var. *lobata*) in South Africa. This species is a notorious invader in North America.

Dr Geerts and his colleagues conducted a national survey and found seven populations of Kudzu vine in South Africa, covering an area of 74 hectares (Figure 14). Using models that predict where Kudzu vine is likely to thrive, the researchers found that the climate is suitable for Kudzu vine across the eastern escarpment and parts of KwaZulu-Natal, while the models suggested that the rest of the country is climatically unsuitable.

In the USA Kudzu vine has taken over many areas and removing it costs the country millions of dollars each year. Dr Geerts and co-workers found that South African populations of Kudzu vine have a similar ecology to populations in the USA, with high growth rates, low seed germination rates, no natural long-distance dispersal, little herbivory and the ability to resprout vigorously after a fire. Unlike the USA populations, however, most South African populations produce flowers, and the flowers can produce seed without the need for insect pollinators. Kudzu vine should therefore be at least as invasive in South Africa as it is in the USA.

The paper suggests that the reason that Kudzu vine is not (yet!) a major problem in South Africa is because it has a short residence time in the country and has not be widely disseminated. It seems that the species was introduced to South Africa in the 1930s as fodder for horses. It was never widely planted, and the species was for many years only present at a single site. By contrast, in the USA there was a concerted effort to plant Kudzu vine for fodder and erosion control, with, in some cases, governmental funding provided to encourage Kudzu vine plantings. In South Africa, many of the plants are found on roadsides where mowing is an important cause of spread.

The lesson is simple. If an invasive species is planted more often, the future invasions will likely be larger and any negative impacts much greater. "*The comparison between the invasions of Kudzu vine in the USA and South Africa highlights the often over-riding importance of human-assisted dispersal and cultivation in causing widespread invasions. This should serve as a warning to people who have proposed to use this species elsewhere in Africa,"* says Dr Geerts.

Figure 14: (a) Kudzu vine (*Pueraria Montana* var. *lobata*) invasion of a *Eucalyptus* plantation close to the initial introduction site in Mpumalanga, South Africa; (b) Kudzu vine smothering native and alien riparian vegetation at the site of initial introduction (Image: Sjirk Geerts).

WATER HYACINTH AS A POTENTIAL AGENT FOR PHYTOREMEDIATION

C·I·B researchers based at the University of the Witwatersrand demonstrated that the invasive aquatic weed, water hyacinth (*Eichhornia crassipes*), can be used to remove metal pollutants from

water (Newete *et al*. 2016; *Environm. Sci. Poll. Res*. 23: 23: 20805; see also Newete *et al*. 2016; *Biol. Cont*. 79: 101–109). Through a process called phytoremediation — literally a green technology — plants are used to remove pollutants from the environment by absorbing them into their roots.

Figure 15: Dr Solomon Newete from the University of the Witwatersrand measuring the removal of metal salts from water by the invasive weed, water hyacinth (*Eichhornia crassipes*) (Image: *Solomon Newete*)

Water hyacinth is characterised by fast growth and despite being a notorious and aggressive invader, it has been widely researched as a potential agent for phytoremediation. Its efficiency, however, relies on the type of contaminant, concentration and eventual storage site in the plant tissues. In the study, C·I·B Core Team Member Marcus Byrne and his co-workers performed a series of experiments on water hyacinth to see whether it is able to remove metal salts from water; where it stores the metal pollutants and how it responds to metal toxicity (Figure 15). Experiments were conducted as single element trials with one each for gold (Au), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), Uranium (U) and zinc (Zn).

The results showed that over 80% of the metal contaminants in the water were removed by water hyacinth. Up to 98% were accumulated in the roots, of which 30% - 52% was adsorbed to the root surface.

"Tolerant plants retained most of the heavy metals in their roots, where the toxicity is minimal, while others reduce the metal toxicity in the shoots by excreting the cations. This is a strategy by which water hyacinth avoids toxic metals reaching the more susceptible shoots," explains lead author Dr Solomon Newete.

Bioconcentration is a process by which the quantity of a chemical in an aquatic organism exceeds that of its concentration in the water surrounding that organism. The bioconcentration factor of copper (Cu), mercury (Hg), gold (Au) and zinc (Zn) in the study exceeded 1 000, meaning that water hyacinth is a hyper accumulator with regards to these metals. The study found that water hyacinth was generally tolerant to all the metal contaminants, except for copper (Cu) and mercury (Hg). "Although water hyacinth has the potential for many phytoremediation roles, this must be weighed up against its ability to invade waterways," says Dr Newete. "Knowing whether metals are

adsorbed, or assimilated in the plant and their allocation between the roots and shoots will inform decisions how to re-treat the biomass for metal recovery, or safe disposal after phytoremediation."

1.2.4 Global environmental change and ecosystem services

STUDY SHOWS THAT INVASIVE SPECIES CAN HAVE CROSS-ECOSYSTEM IMPACTS

Competition and sharing of resources, such as food and space, is important for the structuring of ecological communities. Species that use the same resource may compete with one another, and a new invasive species is often more successful when it can use a resource that is not preferred by native species. A study led by C·I·B post-doctoral researcher Dr Michelle Jackson found that invasive species can have effects that reach across different ecosystems (Jackson *et al*. 2016; *Ecol. Evol*. 6: 1745–1752).

Studies on the sharing of resources usually consider species that occur in the same habitat, for example, the diets of invasive fish often overlap with the diets of native fish. However, species that are not in the same habitat may also compete for the same resources. For example, flying insects, which are an important diet item of birds, bats and spiders, often have an aquatic larval stage. These larvae are also important in the diet of many fish species. To examine this notion further, Jackson and her co-workers assessed the diet of native fish, invasive fish and native spiders in six streams in South Africa (Figure 16).

Figure 16: C·I·B MSc student Hermina Fourie sampling for invasive trout and native fish species such as mountain catfish (*Amphilius natalensis*) and chubby head barb (*Barbus anoplus*). Image: Michelle Jackson

The study showed that spiders were more likely to share resources with invasive trout than native fish, including the mountain catfish (*Amphilius natalensis*) and chubby head barb (*Barbus anoplus*). The likelihood of spiders overlapping into the trophic niche of invasive brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) was as high as 26% and 51%. In contrast, the likelihood of spiders overlapping into the trophic niche of native fish was always less than 5%. "The results suggest that native spiders share resources with invasive fish, adding to the growing body of evidence that invaders can have cross-ecosystem impacts. Competition for resources across the aquatic–terrestrial ecotone should be considered as a far reaching impact of invasive fishes" says Jackson.

LONG-TERM STUDY HIGHLIGHTS ECOLOGICAL CHANGES IN AN URBAN ESTUARY

Estuaries are among the most vulnerable of marine ecosystems and small, urban estuaries, in particular, are under pressure due to human activities (Figure 17). This can cause changes in the invertebrate and fish communities, according to the results of study undertaken by a group of researchers including C·I·B Core Team Member Charles Griffiths (Viskich *et al*. 2016; *Afr. J. Marine Sci*. 38: 23–37).

Figure 17: The alien polychaete, *Ficomomatus enigmaticus*, forms large calcified reefs around the pilings of bridges and other hard structures in small, urban estuaries (Image: Charles Griffiths).

In the study the researchers surveyed the Milnerton (or Diep River) estuary in Cape Town. This estuary is an example of an estuary that has long been subject to human activities for example, pollution, the introduction of alien species and physical modification (e.g. bridges, seawalls etc.) and data from previous surveys were available. *"We were fortunate that two previous studies had surveyed the estuary in the early 1950s and again in 1974, both using similar methods. We repeated those historic surveys in 2014, again using the same methods"* explains Griffiths.

The study showed changes in the physical conditions of the estuary and in the invertebrate and fish communities since earlier surveys. The introduction of sewage effluent into the upper reaches of the estuary has resulted in declines in summer salinity readings. The 1950s survey recorded 47 invertebrate species, but this declined to 23 in 1974 and remained at that level in 2014, although many of the 2014 species were previously unrecorded. In the 1950s, 12 fish species were recorded and this declined to nine in 1974 and just five in 2010, two if which were newly-recorded alien species - thus only three of the original 12 fish species were still present. In contrast, birds were more diverse and more numerous.

"Alien species also have major impacts on this small estuary, particularly polychaete, *Ficomomatus enigmaticus*. Two other newly introduced invertebrates, plus one newly introduced and one newly translocated fish were also recorded in the 2014 study" says Griffiths.

THE POTENTIAL FOR HIGH INTENSITY FIRES TO BE USED TO REVERSE BUSH ENCROACHMENT IN THE KRUGER NATIONAL PARK

Repeated high-intensity fires can reduce bush encroachment, but they also speed up the loss of tall trees. These findings came from a study done by a team of researchers including C·I·B core team member Brian van Wilgen (Smit *et al*. 2016; *J. Appl. Ecol*. 53: 1623–1633).

Figure 18: Large-scale fire experiment in Kruger National Park, South Africa, used to test the effectiveness of high intensity fires for reducing the cover of woody shrubs (Image: Izak Smit).

Grasslands and open savannas are continuously being invaded by woody plants (a phenomenon commonly called bush encroachment, and similar to invasions of alien species in several respects) and scientists predict that the extent of this phenomenon will grow as the level of CO_2 in the atmosphere increases. Herbicides or mechanical clearing can be used to reverse bush encroachment, but are expensive and impractical over large areas. One suggested method to reverse bush encroachment is the use of high intensity fires that would reduce woody shrub cover, while leaving tall trees unaffected (Figure 18).

To test this idea, South African National Parks, with logistical support from Working on Fire conducted a fire experiment to see whether high intensity fires could be used to reverse bush encroachment in the Kruger National Park. Using LiDAR remote-sensing technology, the team of authors from South African National Parks, Carnegie Institution of Science, and the C·I·B compared the vegetation cover and height in areas exposed to repeated high intensity and low intensity fires, as well as areas protected from fire, before and after the different fire treatments. The research revealed that two successive high-intensity fires reduced bush cover. In comparison, the areas burnt by two successive low intensity fires became even denser over the 4 year study period.

"The high intensity fire was successful, at least in the short term, in reducing bush cover, but we were surprised at the number of tall trees, exceeding 10 meters, that collapsed following high intensity fires" says van Wilgen.

Tall trees are normally considered to be unaffected by fires because their canopies are above the flame-zone, but in this experiment, more than a third of tall trees collapsed after two successive high intensity fires. Trees were apparently vulnerable to high intensity fires because elephants remove bark within the flame-zone height which causes the wood to dry and become vulnerable to wood borer infestations. These weak points enable high intensity fires to set the stem alight and lead to toppling of the tree.

"We were hoping our results would show that high intensity fires could be used to reduce cover of encroaching shrubs. Although we confirmed this, at least in the short term, the accompanying damage to tall trees creates a management conundrum" explains van Wilgen.

The researchers suggest "that one solution may be to repeatedly apply high-intensity treatments to some areas, and not to others, to generate a heterogeneous landscape where grasses become dominant and tall trees scarce in some places, but in others tall trees remain and shorter woody shrubs increase (see Figure 19). We predict that in areas without elephants or with lower elephant densities, high intensity fires may have less of an impact on tall trees".

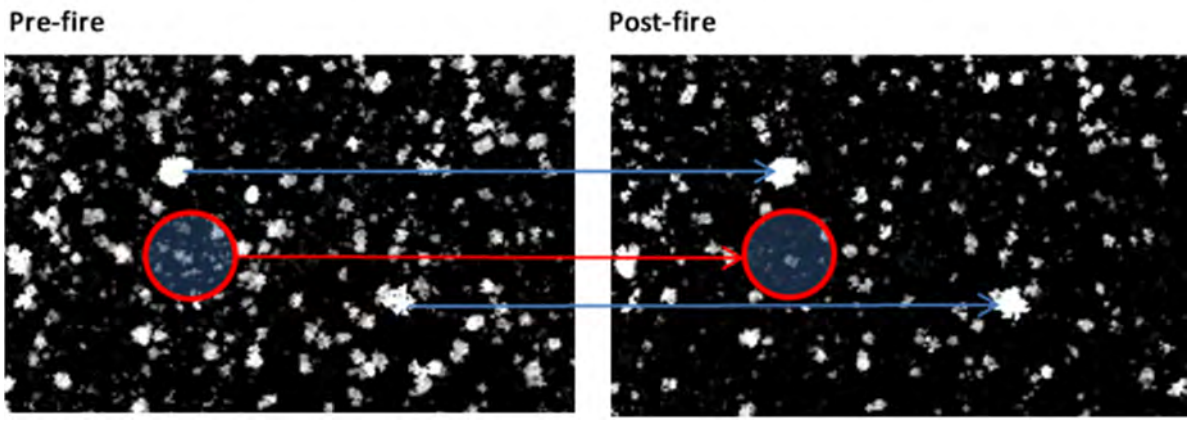


Figure 19: Pre- and post-fire information on the same area, showing how 3D vegetation structure was affected by high intensity fire (black shows ground cover, and grey-to-white shows the increasing height of woody vegetation; blue lines show examples of large-canopy trees observable both before and after fire treatments, whereas the red circle highlight an area where fire reduced cover of small shrubs) (Image: Izak Smit)

1.2.5 Human dimensions

SCORING ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS OF ALIEN PLANTS INVASIVE IN EUROPE

The Generic Impact Scoring System (GISS; see 1.2.3) has proved a helpful tool for managers to identify invasive alien plant species with high environmental and social impacts. This was one of the findings from a study, co-authored by C·I·B Research Associate Prof. Petr Pyšek, where the GISS was used to categorize invasive alien plant species in Europe based on their environmental and socioeconomic impacts (Rumlerová *et al*. 2016; *Biol. Invasions* 18: 3697).

The GISS was originally developed for mammals introduced into Europe, but has since been applied to other groups of alien organisms in Europe, for example, birds, amphibians and fish. This scheme has become the basis of a conceptual framework for all groups of organisms.

The study evaluated the impact of 128 alien plant species in Europe. Based on information in the literature, their environmental and socioeconomic impacts were assessed and assigned to one of six different categories. In each category, the impact was classified on a five-degree scale, which reflects the intensity of the impact. The authors then used the maximum score recorded for each category and their sums to identify species with the greatest impacts.

They found that environmental impacts are most often manifested as competition with native species (recorded for 83% of the species), while socioeconomic impacts are associated mostly with human health (78%). "*We also found that the sums of environmental and socioeconomic impacts were significantly correlated. This means that species with a high environmental impact have specific traits that are also associated with a high economic impact, for example, the aquatic invasive water hyacinth (Eichhornia crassipes)"* explains Pyšek (see Figure 20).

In terms of plant life forms, annual plants have on average lower environmental impacts than perennial plants, and aquatic species have a higher socioeconomic impact than other life forms. Pyšek commented on the relevance of the study, "Applying the GISS to plants, the most species-rich taxonomic group of alien organisms in Europe, is an important step towards providing managers and policymakers with a robust tool for identifying and prioritizing alien species with the highest impact. It can also serve as an early warning tool, by focusing on species that are not yet widespread in Europe because they arrived only recently or are restricted in their distribution by factors, which may change in the future."

Figure 20: *Eichhornia crassipes* (water hyacinth), an aquatic plant native to the Amazon basin, is a highly problematic invasive species in many areas outside its native range. (Image: John Wilson).

HOW TO PRIORITISE INSPECTIONS AT BORDERS TO PREVENT INVASIONS

Research conducted by C·I·B post-doctoral researcher Dr Katelyn Faulkner (with C·I·B Core Team Members Mark Robertson, Mathieu Rouget and John Wilson), showed that border control should focus on vectors that transport many alien species from countries with climates similar to that of South Africa.

In an attempt to prevent biological invasions, border control authorities inspect transport vectors of alien species (e.g. shipping containers, the luggage of tourists), but as resources for these inspections are limited, they need to be prioritised. Vectors that transport and introduce many organisms are inspected, but whether the introduced organisms will establish in the new region is not considered.

Using South Africa as a case study, Dr Faulkner and her co-authors determined which of these factors should be considered when identifying priorities for inspections. Dr Faulkner and her co-authors used tourism and trade data as a proxy for the number of species introduced to South Africa from foreign countries, and climate matching techniques to determine the likelihood that the introduced organisms would establish once they arrived in South Africa (Faulkner *et al*. 2016; *J. Environm. Manage*. 180: 301-309).

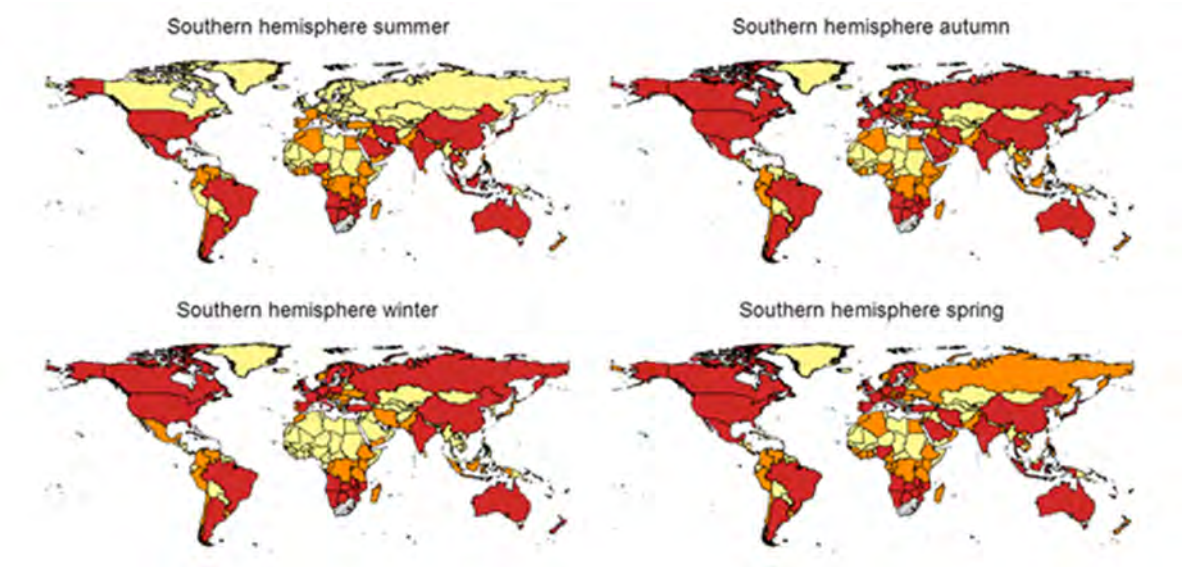


Figure 21: The number of alien species that will be introduced and establish in South Africa varies across donor countries and seasons. The map shows the seasonal variation (based on southern hemisphere seasons) in the countries from which a low, medium or high number of species with the potential to establish will be introduced to South Africa. (Image: Katelyn Faulkner).

The study showed that the number of alien species that will be introduced and establish varies across donor countries and seasons (Figure 21). A theoretical model showed that the best way to identify inspection priorities is to include the number of species and their likelihood of establishing. This strategy was more effective in detecting a higher number of potential invaders and less inspection effort was needed to detect these species.

According to Faulkner, "our results suggest that to prevent invasions, we should not only consider the number of species that will be introduced from a country, but also the similarity of the countries' climates. However, it is important to note that as climatic similarity varies seasonally the identified priorities will have to be updated regularly".

2 Education and training

2.1 Objectives

Our research takes place mainly through post-graduate and emerging researcher (post-doc) training. It is thus crucial that the Education and Training Key Performance Area incorporates excellence and equity. Thus, the C·I·B aims not only to develop science capacity in South Africa, but also to produce cohorts of graduates who excel and are increasingly representative of South Africa's population.

Our criteria for student support are:

- Equity targets set in the Service Level Agreement
- Match with C·I·B Vision and Mission
- Match with C·I·B annual business plan
- Match with priorities of partners (especially WfW, SANBI and conservation agencies)
- Synergies with SANBI/SARChI Chair bursaries through co-funding
- Spread among C·I·B Core Team Members, universities and freshwater, marine and terrestrial environments
- History of C·I·B Core Team Member productivity.

The C·I·B core management team considers student and post-doc applications in the context of the support structures within a research group and provides advice and support to Core Team Members on how matters can be arranged to support students and to help ensure their success. The Core Team Members are expected to solicit applications from good students, to take on these students for training, to create an inclusive and well-supported post-graduate student training environment and to provide additional mentorship where necessary. No students are funded unless the C·I·B management is satisfied that appropriate supervisors, facilities, and mentoring opportunities exist. From an equity perspective, the C·I·B takes a wide range of actions and the major ones are listed below:

Within the C·I·B hub students are provided with mentoring opportunities via a vibrant, mixed group of post-doctoral associates, and pairing of senior and more junior students. Details such as seating arrangements, journal clubs, laboratory meetings and student presentations are considered to best enable appropriate mentoring. The C·I·B awards good bursaries which include substantial running costs for support of student projects. Whilst it has a fixed closing date at the end of each year and awards most bursaries then, it retains an element of flexibility to allow late-comers from the designated groups to gain access to support. The annual student awards for the best presentations

at the C·I·B's research meeting provide substantial funding for an overseas lab visit or conference attendance.

Student contracts specify clearly what is expected from students and supervisors, what they can expect in return, and what the consequences are of inadequately justified poor performance. Student progress is monitored on a regular basis, and flexibility is built into the system to ensure that performance is managed acknowledging the diverse range of personal contexts within which students operate. Ad hoc short courses and workshops are presented to C·I·B students and Core Team Members on aspects of the science system and scientific practice.

2.2 Progress

2.2.1 C·I·B doctoral graduates in 2016

Four C·I·B students graduated with PhDs in 2016. All have been employed in partner organisations or are continuing in research careers.

Following his PhD, **Terence Bellingan** is doing contract work for the South African Institute for Aquatic Biodiversity (SAIAB) on a Water Research Commission (WRC) project on the Krom Rivier in the Cederberg, monitoring the effects of CapeNature's alien fish control operations. Terence also teaches and mentors Honours students from historically black universities in the art of freshwater ecological research (a SAIAB and WRC funded project) and will continue to a post-doctoral fellowship at Rhodes University in 2017.

Desika Moodley is working on invasive Australian trees and shrubs with the South African National Biodiversity Institute's Invasive Species Programme. Desika manages a research programme on invasive Australian trees and shrubs in South Africa by developing a national surveillance strategy, managing the target species, collaborating with the regional co-ordinators and linking with local researchers and students. Dr Moodley is compiling a database of Australian trees and shrubs, their status, and all ongoing and completed research. Her next focus will be on forming an Australian trees and shrubs working group which will steer research on this group.

Tom Bishop was a C·I·B-affiliated PhD student, and obtained his PhD at Oxford University (independently funded). Dr Bishop has now taken up a Vice-Chancellor's Postdoctoral Research Fellowship at the University of Pretoria, working on thermoregulatory traits of insects. Dr Bishop develops models to predict and describe the impacts of climate change-related shifts in temperature and ultra-violet radiation on ant communities. He has also initiated a novel long-term experiment which is manipulating the thermal and bio-geochemical environment under which ant colonies grow and survive.

Giovanni Vimercati will take up a post-doctoral position with Jean Secondi (University of Angers, France) and Dennis Rödder (Zoological Research Museum Alexander Koenig, Bonn, Germany) early in 2017. Dr Vimercati will develop a connectivity model of invasive populations of African clawed frogs (*Xenopus laevis*) and American bullfrogs (*Lithobates catesbeianus*) in Europe. Clawed frogs and bullfrogs have been spreading in Europe for a long time, and it is not feasible to eradicate them. The model will map the likely path of invasion and identify control strategies that can be 'tested' in the model environment before being applied in the field.

2.2.2 Awards

Dr Raquel Garcia was awarded a L'Oréal-UNESCO Regional Fellowship For Women in Science, on Wednesday 29 September. The objective of the Regional Fellowships is to support young women pursuing scientific careers. Her project is titled 'Effects of plant invasions on native ectotherms under a warming climate'. The fellowship will support the field component of Dr Garcia's research on the effects of climate change and plant invasions on native reptiles. Together with Prof. Susana Clusella-Trullas, she will be tracking tortoises in the field to compare their activity patterns and thermo-regulatory behaviour in areas of pristine vegetation and in areas invaded by alien plants.

2.2.3 Funding

The bulk of our studentships and post-doc fellowships were funded by the core CoE grant from the DST-NRF. However, significant funding from the NRMP programme of the Department of Environmental Affairs and the Invasive Species Programme of the South African National Biodiversity Institute (also a branch of DEA) allowed us to conduct collaborative research with NRMP and achieve synergies with our key partner, ISP. A variety of independent funding sourced by

researchers, students and post-docs allowed us to support an extra 26 students and 11 post-doctoral fellows.

Raquel Garcia (C·I·B post-doc, second from left) receives the L'Oréal-UNESCO Regional Fellowship for Women in Science (FWIS) in Sub-Saharan Africa

2.2.4 Visiting students

We also offered desk and bench space to visiting students and post-docs from Brazil, Italy and Spain. **Thalita Zimmermann** from Laboratorio De Semente, Instituto De Pesquisas Jardim Botanico Do Rio De Janeiro, Brazil spent six months based at the C·I·B in 2015 and 2016 to complete her PhD on the invasive tree species *Casuarina equisetifolia*. Dave Richardson was external co-supervisor of her thesis. Her stay at the C·I·B resulted in two publications. **Jonatan Rodriguez** is a PhD student at the Universidade de Vigo (Spain) under the supervision of Prof. Luis Gonzalez. As part of his PhD, Jonatan undertook a field project in South Africa, spending three months at the C·I·B under the co-supervision of Dr Ana Novoa (C·I·B post-doctoral associate). In Spain, Jonatan's research is mainly focused on the study of plant-insect interactions, especially regarding the invasive plants *Acacia dealbata* and *Carpobrotus edulis* (sour fig). During his stay, Jonatan studied the interactions of *Carpobrotus edulis* with insects in its native range in South Africa. Jonatan is currently comparing the results he obtained in Spain with those he obtained in South Africa. This collaboration will result in at least one publication. **Andrea Garbin** is an MSc student at the University of Urbino Carlo Bo (Italy) under the supervision of Prof. Maria Balsamo. Andrea spent three months at the C·I·B under the co-supervision of Dr Mirijam Gaertner, working on the ecology and management of the invasive alien Mexican water lily (*Nymphaea mexicana*) in the City of Cape Town.

2.2.5 Internships

The C·I·B does not offer internships *per se*, but sources internship support from the NRF programmes and also hosts SANBI interns at our hub in Stellenbosch. In 2016 we hosted three interns from SANBI and one NRF intern.

2.2.6 Demographic breakdown of post-graduate students and post-docs

Table 4. Demographic information on the 2016 student and post-doctoral associate group

	No.	%
All supported students	**71**	**100**
By academic level		
Honours/4th year B. Agric.	**9**	**13**
Masters	**34**	**48**
PhD	**28**	**39**
By gender		
Male	**31**	**44**
Female	**40**	**56**
By race		
Black	**33**	**46**
White	**38**	**54**
By funding level		
Full	**31**	**44**
Partial	**14**	**20**
Independent	**26**	**37**
By citizenship		
South African	**57**	**80**
Foreign	**14**	**20**

	No.	%
All supported post-docs	**16**	**100**
By gender		
Male	**6**	**38**
Female	**10**	**62**
By race		
Black	**0**	**0**
White	**16**	**100**
By funding level		
Full	**5**	**31**
Partial	**0**	**0**
Independent	**11**	**69**
By citizenship		
South African	**6**	**38**
Foreign	**10**	**62**

2.2.7 Under-graduate training initiatives

Invasion Ecology third year course (Stellenbosch University)

The C·I·B is wholly responsible for a third-year undergraduate module on Invasion Ecology that is being taught within the Department of Botany and Zoology. C·I·B Core Team Member Jaco Le Roux is the course coordinator with teaching assistance from Brian van Wilgen, John Measey, and post-doctoral fellow Florencia Yanelli. The course covers a wide range of current topics in invasion science, including: transport vectors and pathways, propagule pressure, evolutionary biology, dispersal modelling, impacts and management of invasive organisms. In 2016, 48 undergraduate students took the course. The C·I·B is involved in this module to stimulate interest in invasion ecology among advanced under-graduate students, in the hope of attracting post-graduate students in the future.

Summer school on biological invasions dedicated to risk assessment (University of Reunion, France)

Core Team Members Sabrina Kumschick and Brian Van Wilgen delivered a course and practical on risk assessment – i.e. the likelihood and consequences of alien species becoming harmful invaders in a new range, and the management of such risks. This included the study of pathways of entry, establishment success, dispersal, as well as impacts and the ease of management. The course contained introductory theory, as well as practical parts where participants collected data on specific species to assess aspects of risk. Around 50 participants, including local biodiversity managers, from Seychelles, Rodrigues, Mauritius, Réunion, South Africa and Comoros took part.

2.2.8 Career development

Table 3. Whereabouts of a selection of our graduates from the past five years

Name	Level	Institution	Current position	Race	Gender
Ms Enelge Gildenhuys	Masters	SU	Africa Development Manager, Mainstream Renewable Power, Cape Town	W	F
Mr Llewellyn Jacobs	Masters	SU	Scientific Technician, CapeNature Scientific Services	B	M
Ms Marinel Janse van Rensburg	Masters	SU	Researcher, Oceanographic Research Institute in Durban	W	F
Dr Elizabeth Kleynhans	Masters	SU	Area Manager, Subtropical Fruit Growers Association	W	F
Ms Haylee Kaplan	Masters	SU	Research and GIS technician: Invasive Species Programme, SANBI	W	F
Mr Dickson Mazibuko	Masters	SU	Lecturer, University of Malawi, Chancellor College, Malawi	B	M
Ms Alexis Olds	Masters	Rhodes	Project Manager, Marine Protected Areas, Islands and Estuaries, CapeNature Scientific Services	W	F
Ms Nolubabalo Tantsi	Masters	UP	Junior Scientist, SANParks	B	F
Ms Julia van der Merwe	Masters	SU	Environmental officer, DEA, Cape Town	W	F
Dr Tanya Haupt	PhD	SU	Post-doctoral Associate, Dept. Animal Science, Stellenbosch University	B	F
Dr Rene Gaigher	PhD	SU	Research Associate, Dept. Conservation Ecology and Entomology, Stellenbosch University	W	F
Dr Candice Lyons	PhD	SU	Researcher, Biological Control of Invasive Weeds, Plant Protection Research Institute	W	F
Dr Joice Ndlovu	PhD	SU	Lecturer, Chinhoyi University of Technology, Zimbabwe	B	F
Dr Sheunesu Ruwanza	PhD	SU	Senior Lecturer, Department of Botany, University of Venda	B	M
Dr Genevieve Thompson	PhD	SU	Senior Researcher, Biotechnology Platform, Agricultural Research Council	W	F
Dr Lize-Marie Van der Watt	PhD	SU	Researcher (history) at Kungliga Teckniska Högskolan, Sweden	W	F
Dr Tsungai Zengeya	PhD	UP	Reporting coordinator for the *National Status Report on Biological Invasion in South Africa*, SANBI	B	M
Dr Jessica Allen	Post-doc	SU	Ecological Researcher, C_4 EcoSolutions, Cape Town	W	F
Dr Natasha Mavengere	Post-doc	SU	Senior Scientist, Quorus Biotech	B	F
Dr Matthew McConnachie	Post-doc	SU	Environmental consultant, LTS International Edinburgh	W	M
Dr Christopher Weldon	Post-doc	SU	Lecturer, Department of Zoology and Entomology, University of Pretoria	W	M

3 Networking

3.1 Objectives

The C·I·B continues to encourage a variety of approaches to scientific excellence, and facilitate networking among its members and with like-minded individuals and organizations in South Africa

and abroad. In consequence, networking forms a critical component of the C·I·B's work. The Visiting Fellows programme will remain an important way to maintain and develop partnerships, particularly in the international sphere.

3.2 Progress

3.2.1 Agreements with partner institutions

The C·I·B works with a variety of organisations from those that host our core team members (collaborating institutions) to those with whom we work on joint student projects or long term monitoring or outreach (partners) (see Figure 21). All these relationships are backed by memoranda of understanding that set out the terms of the interaction and the roles of the parties. Some of our longest-standing and most essential partnerships are those with our collaborating HE institutions that host the Core Team; the Western Cape Education Department, which facilitates Iimbovane' s work, and the NRM Programme of DEA, which provides generous funding for capacity building in biological invasion research. Members of the Centre interact closely with several international organisations and networks.

Figure 21. Partner organisations of the C·I·B (memoranda of understanding signed)

3.2.2 Interaction with peers

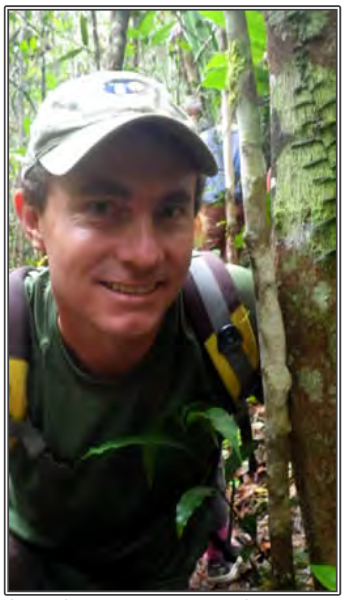
Sri Lankan Overseas Training Programme on Invasive Species

On 25 October, the C·I·B assisted DEA: NRMP, one of the C·I·B's key partners, to host a delegation of 24 Sri Lankan researchers and decision-makers from a diverse range of environmental organisations in Sri Lanka. The visit was part of an Overseas Training Programme on Invasive Species for the Officers of Sri Lankan Stakeholder Institutions. Delegates came from twelve different organisations in Sri Lanka, with a range of mandates - from river catchment management to urban water supply management, biodiversity, conservation and agriculture, in government and NGOs. Nine C·I·B Core Team Members and staff presented aspects of their work to inform the Sri Lankan stakeholders of our approach to research on and management of invasive alien organisms; the presentations were followed by a discussion session and an informal lunch.

Delegates from Sri Lanka and C·I·B team members during the Sri Lankan Overseas Training Programme on Invasive Species in October 2016

Fellowship Programme

Prof. James Vonesh, Virginia Commonwealth University, USA



James Vonesh's research is focused on predator-prey ecology, size- and stage-structured processes in populations and communities, and how organisms with complex life cycles link aquatic and terrestrial food webs. He is the author of more than 40 papers and an Associate Editor for Conservation Biology and Freshwater Science. James spent January 2015 to July 2016 at the C·I·B as a Fulbright Fellow. During his stay, he collaborated with C·I·B team members, lectured in the Department of Botany and Zoology, and supervised and mentored several C·I·B students working on invasive predators in freshwater systems.

With C·I·B masters student Corey Thorp, James conducted a mesocosm experiment examining the trophic interactions of the African clawed frog (*Xenopus laevis*) to better understand the role of natural enemies in regulating this species in its native and invasive ranges. African clawed frogs are invasive in Europe, Asia, and North and South America. Three C·I·B students who submitted their theses in 2016 (Giovanni Vimercati, Alex Rebelo and Corey Thorp) acknowledged James Vonesh for interactions which improved the quality and insight of their work. James' visit to UKZN explored ways in which to extend an existing MoU between the institutions with the C·I·B's Colleen Downs, using Invasion Science as a common theme. While he was in SA, James developed a field course for students from the United States to study in KZN over the winter break. The *South African Summits to Sea: Human and Natural History of KwaZulu-Natal biology* course takes a small group of students from the peaks of the Drakensberg—the rooftop of Africa — to the low-lying freshwater lagoon of Kosi Bay. At points between, they visit the Tugela, Pongola and Buffalo rivers. The course was implemented for the first time in January 2017 following James' return to the US from South Africa and will ensure ongoing interaction between the C·I·B, other SA institutions and Virginia Commonwealth University.

Dr Arne Witt, Centre for Agriculture and Bioscience International, Kenya

Arne Witt is the Centre for Agriculture and Bioscience International's (CABI) Africa and Asia Coordinator for Invasive Species based in Nairobi, Kenya. Dr Witt has extensive experience researching the biological control of alien plant species. During his visit to the C·I·B, Dr Witt worked closely with Dave Richardson, Brian van Wilgen and C·I·B post-graduate students on an extensive East Africa dataset on the distribution,

costs, and detrimental impacts of invasive alien for local livelihoods and biodiversity. Dr Witt collaborated with Brian van Wilgen and C·I·B post-doctoral fellow Ross Shackleton on documenting the extent and impacts of invasive alien plants in East Africa. The impacts of *Lantana camara*, *Chromolaena odorata* and alien cacti on the livelihoods of poor rural people in East Africa were surveyed using household questionnaires, and three papers were submitted for publication. Most households express concern about alien plant invasions, and have pointed to significant impacts on their dependence on natural resources and their quality of life. Richardson, Shackleton and Witt collaborated on a study of the distribution and socio-ecological impacts of *Chromolaena odorata* in East Africa; a paper on this topic was accepted for publication in *Biological Invasions*. Another paper on the threats posed by alien plants to the Serengeti-Mara ecosystem has been accepted for publication in *Koedoe*. Currently, the Serengeti-Mara ecosystem is relatively free of widespread and abundant invasive alien plants, with a few exceptions, but there are extensive populations outside of the ecosystem, particularly to the west, from where they could spread if steps are not taken to prevent this. The study addressed the potential impacts of six species that we consider to pose the highest risks (*Parthenium hysterophorus*, *Opuntia stricta*, *Tithonia diversifolia*, *Lantana camara*, *Chromolaena odorata* and *Prosopis juliflora*).

Prof. Sven Bacher, University of Fribourg, Switzerland

Sven Bacher is a professor at the University of Fribourg, Switzerland. He has worked on biological invasions for more than 15 years and is particularly interested in conceptual issues and syntheses that improve the field. Sven has worked on most parts of the invasion process and with various taxonomic groups (insects, vertebrates, plants), and serves as an alien species expert for the European Commission and for the Swiss and German Ministries of the Environment. During his C·I·B fellowship, Sven collaborated with Cang Hui, Sabrina Kumschick, Dave Richardson, John Wilson and other C·I·B members on projects aiming at developing generic methods for classifying impacts of alien species. Of particular importance was the development of a method to classify socio-economic impacts, analogous to the recently proposed Environmental Impact Classification of Alien Taxa (EICAT) for environmental impacts (Blackburn *et al.* 2014; *PLoS Biology* 12: e1001850). This collaboration is continuing after the fellowship ended as Sabrina is co-supervising Sven's PhD student whose project involves testing and implementing the newly developed method. Furthermore, various new ideas for collaborative projects have emerged from Sven's time at the C·I·B. Thus he participated in a workshop hosted by the C·I·B in November on Urban invasions, and is organising a workshop on *Biological Invasions – Challenges for Science and Society* to which Sabrina is invited as an expert.

Dr Brett Bennett, University of Western Sydney, Australia

Brett Bennett is a Senior Lecturer in Modern History at Western Sydney University, Australia. His research uses historical methods to investigate how the interaction of human actions and natural processes create contemporary ecosystems, scientific ideas, and conservation policies. He is particularly interested in the history of alien species introductions, naturalisation and invasion from global and South African perspectives. During his C·I·B Fellowship in 2016 interacted with many C·I·B staff and students on projects focussing on the merging of historical and scientific understandings of biological invasions. A publication with the working title "The Globalization of Invasive Species, c. 1500-2000: Bridging Historical and Ecological Perspectives" will be the main product of the C·I·B Fellowship, but several other projects are likely to flow from discussions initiated at the C·I·B.

Prof. Scott Carroll, University of California at Davis, USA

Scott Carroll is an evolutionary biologist and ecologist affiliated with the University of California, Davis. His main research interests are in exploring contemporary evolution to better understand adaptive processes and how those processes can be harnessed to develop solutions to evolutionary challenges in food production, medical care and environmental conservation. Scott visited the C·I·B during November-December 2016, hosted by Jaco Le Roux. This was a fruitful collaboration during which Scott interacted with various Core Team Members and students. Scott and Jaco conducted field research in KZN on invasive *Cardiospermum grandiflorum* with the main aim of inferring whether native soapberry bugs from the genus *Leptocoris* are able to utilize this invasive plant as a primary host. This may lead to the researchers identifying South African insects that may aid biocontrol of invasive *Cardiospermum* vines. During their fieldwork the researchers also recorded new host utilization records of the African soapberry bug, *L. mutilatus*. During Scott's stay the C·I·B also hosted a workshop on 'neoclassical' biological control. The latter resulted in a draft paper which will be submitted for publication in 2017. Scott also delivered a plenary address, 'Prospects for rapidly evolving biological control from native species', during the C·I·B's 2017 Annual Research Meeting.

Prof. Marshall McCue, St. Mary's University, Texas, USA

Marshall McCue is an Associate Professor at St. Mary's University in San Antonio, Texas (USA). Prof. McCue has authored over 50 international papers and several authoritative reviews on animal digestion and starvation physiology. Marshall received a C·I·B Fellowship and visited the lab of Prof. Susana Clusella-Trullas from November to December 2016. During his stay, a project was initiated to examine the temperature dependence of nutrient assimilation in a native lizard using dietary stable isotope enrichment. Marshall also led a dynamic workshop involving 35 participants including C·I·B students and postdocs on the potential use of stable isotopes to study various aspects of biological invasions. This workshop catalysed many new ideas and a review publication is in preparation on this theme involving several C·I·B Core Team Members. Several students and postdocs benefited from multiple interactions with Marshall, especially in the lab environment where hands-on training was given in aspects of stable isotope sample preparation and methodology. Through Marshall's expert training and continued interactions, several projects are underway which now involve stable isotope techniques applied to several invasive species (e.g. ladybirds) and which would otherwise not have been feasible. Marshall continues to provide feedback and input on diverse aspects of several projects and we expect a suite of high quality publications to follow from this fellowship visit.

Prof. Bethany Bradley, University of Massachusetts at Amherst, USA

Bethany Bradley from the Department of Environmental Conservation at the University of Massachusetts, Amherst, USA) spent part of her sabbatical leave at the C·I·B between September 2016 and January 2017. During her time at the C·I·B she focused on a meta-analysis of the relationship between invasive species abundance and ecological impact. The research asks whether increasing the number of individuals of an invasive species has the same effect on native communities when abundance is small vs. large and when invasive species interact differently with native species (e.g., competitors vs. predators). She also collaborated with John Wilson on an analysis of dispersal patterns of invasive plants. A start was made with an analysis for a review on interactions between plant invasions and fire and work on this will continue during 2017 and will involve collaborations with several C·I·B personnel.

4 Information brokerage

4.1 Objectives

Information brokerage will continue to be a core component of the C·I·B's business. The Iimbovane Outreach Project is the primary outreach and community interaction activity undertaken by the C·I·B, but we have a range of other outreach and science communication activities. For example, in 2016 we initiated, under leadership of senior researcher John Measey, a podcast series focusing on our research outputs and showcasing two or more researchers talking about their research. Further information brokerage takes place via the dissemination of knowledge through primary scientific literature, scientific books, popular publications, print media, radio and television, and web resources. The C·I·B will continue to make use of the full range of information brokerage mechanisms at its disposal, recognizing that as an essential part of the knowledge economy, it must serve society at a broad range of levels.

4.2 Progress

4.2.1 Workshops hosted

43rd Annual Research Symposium on the Management of Biological Invasions in South Africa (Goudini Spa, 18-20 May 2016)

The C·I·B and SANBI's Invasive Species Programme (ISP) collaborated to host the 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa. This meeting has grown from a bi-annual workshop focused on biological control of weeds to a national conference focusing on the management of biological invasions broadly. It has become the key annual opportunity for invasion scientists, managers and other role-players to interact and exchange knowledge and learning. The C·I·B led the scientific organising committee and jointly arranged the meeting along with SANBI ISP, Agricultural Research Council (ARC) and City of Cape Town. The C·I·B sponsored the keynote speakers, Reuben Keller (Institute of Environmental Sustainability, Loyola University Chicago), Melodie McGeoch (School of Biological Sciences, University of Melbourne) and Bob Scholes (Global Change and Sustainability Research Institute, University of the Witwatersrand).

The aim of the 43rd meeting was to support and inform the *National Status Report on Biological Invasions in South Africa* (NSRBISA). The National Status Report is a requirement of Chapter 5 of NEMBA and the C·I·B is assisting SANBI to produce South Africa's first edition by October 2017. The meeting covered three main themes, (1) the status of invasions (taxa, protected areas, biomes, catchments), (2) the status of impacts (magnitude and trends) and (3) the efficacy of interventions and brought together 173 participants from South Africa's universities, national and provincial government agencies, national facilities, NGOs, SOEs and the private sector. In all, 69 presentations were made by a range of senior South African researchers, demonstrating the capacity that exists to support DEA in the development of the *National Status Report on Biological Invasions in South Africa*.

Delegates at the 43rd Annual Research Symposium on the Management of Biological Invasions.

Since the focus of the meeting was on South Africa, most of the delegates were local, but two international and one SA keynote speakers provided useful insight on large-scale policy development and assessment processes. Bob Scholes (Wits University) opened the meeting with a talk on large-scale assessments based on his experience with the IPCC and IPBES processes, recommending an approach where a multi-author team conducts a balanced assessment and policy-makers are involved in the selection of experts that conduct the assessment; through their involvement, policy-makers gain an understanding of the strength and limits of scientific knowledge and provide the authorisation of the final product. Melodie McGeoch from Monash University used her experience of large invasion monitoring projects such as the CBD and GISP to encourage a focus on a small set of essential variables for monitoring and a modular approach to ensure that knowledge from local, regional and national scale experience is well-connected across scales. Reuben Keller from Loyola University, Chicago, addressed the usefulness of risk assessment processes for preventing the arrival of invasive species and the specific question: how simple and how accurate does a risk assessment tool have to be to be cost effective and suitable for resource-strapped governments to adopt? It turns out that a rapid screen can be as simple as: Is it invasive elsewhere? Is there a climate match? and the tool only needs to be 70% accurate. This is good news, because we already have several tools with this level of accuracy.

Non-native species in urban environments: Patterns, processes, impacts and challenges (Lanzerac, Stellenbosch, 7-9 November 2016)

The workshop took place immediately prior to the Annual Research Meeting and included 43 participants from 8 countries, including Brazil, Canada, USA, Switzerland, Germany, Italy, Czech Republic and South Africa. One of the main aims of the workshop was to discuss whether existing frameworks and paradigms in invasion science are fit for purpose when addressing the escalating problems associated with invasive species in urban ecosystems. A key difference between invasions in urban and more natural ecosystems is the large number of stakeholders in the former which poses special challenges for framing and responding to invasive species issues. The workshop provided the opportunity to discuss a wide range of theoretical and practical issues on this theme, and a special issue of the journal *Biological Invasions* is in preparation. As with other international workshops that the C·I·B has held linked to the Annual Research Meeting, this event was successful

in showcasing the C·I·B's work to an international audience, raising the Centre's international profile, and building new collaborations.

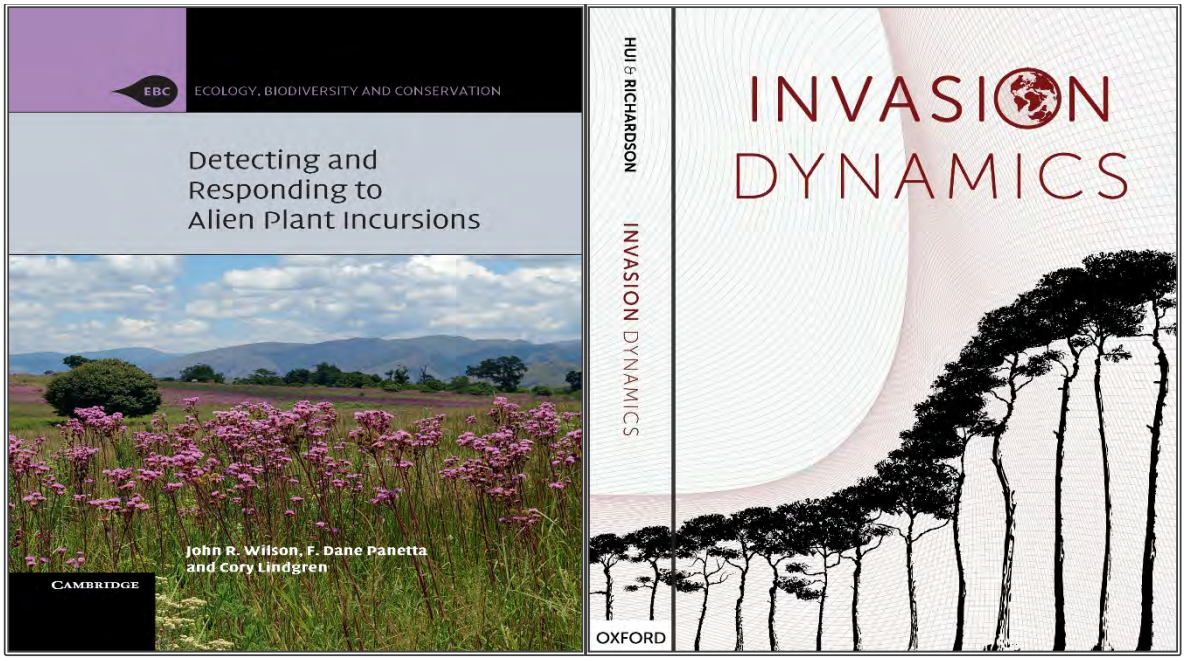
Participants in the workshop on urban invasions held in Stellenbosch from 7 to 9 November 2016

4.2.2 Team events

Annual research meeting

Our Annual Research Meeting (ARM) took place on Thursday 10 and Friday 11 November at Stellenbosch University. We were fortunate to hear from three international keynote speakers who attended. Laura Celesti (Sapienza University, Italy) spoke on 'From the Alps to the coasts of Africa: plant invasions in Southern Europe'; Marc Cadotte (University of Toronto, Canada) talked about 'Understanding Darwin's naturalization conundrum: the importance of time, space and extinction', and Scott Carroll (University of California at Davis) addressed 'Prospects for rapidly evolving biological control from native species'. In a short discussion on gene editing (CRISPR) and its potential costs and benefits for invasive species management, Prof. Laura Meyerson (international science advisor) alerted us to the US white paper on Advanced Biotechnology to manage and eradicate invasive species.

Masters and PhD students presented their work to the team and guests in seven sessions designed and led by post-doctoral associates. The sessions addressed a wide range of topics in invasion biology (see Table 5) and provided great insight into the current state, drivers and management options for invasive species.



Two books written by C·I·B Core Team Members were launched at the ARM. The book by John Wilson, Dane Panetta and Cory Lindgren on invasive species response strategies, 'Detecting and Responding to Alien Plant Incursions' (Cambridge University Press) was published in 2016. Cang Hui and Dave Richardson's book on 'Invasion Dynamics' (Oxford University Press) was published early in 2017.

The C·I·B awards a substantial travel prize to the PhD and Masters students who deliver the best presentations at the ARM. The presentations are judged by an independent panel composed of our international science advisors and visiting fellows or keynote speakers. This year the panel consisted of Piero Genovesi (Chair IUCN SSC Invasive Species Specialist Group), Laura Meyerson (Department of Natural Resources Science, University of Rhode Island) and Bethany Bradley (Department of Environmental Conservation, University of Massachusetts at Amherst). The student awards allow the students to travel to an overseas lab, conference or training course.

Table 5: Session topics at the 2106 Annual Research Meeting

Topic	Coordinator
Multiple aspects and considerations for the management of alien species	Dr Ross Shackleton
Organisms on the move	Dr Laure Gallien
Humans… We Have a Problem	Dr Jennifer Fill
Understanding and predicting invasion potential and impact	Dr Katelyn Faulkner
Interspecific interactions	Dr Melissa Plasman
Let's not lose track: Understanding invasions from introduction to impact	Dr Florencia Yanelli
The role of parasites and disease in biological invasions	Dr Tom Bishop

The winning pod of presenters, who addressed 'Understanding and predicting invasion potential and impact' (L-R: Susan Canavan, Erika Opperman, Katelyn Faulkner (coordinator), Koebraa Peters, Khensani Nkuna, Davina Saccaggi and Cavin Shivambu)

The individual winners of the C·I·B 2016 Presentation Awards (L-R: Marike Louw, Masters winner; Ingrid Minnaar, PhD runner-up; Mmatsawela Ramahlo, Masters runner-up; Koebraa Peters, PhD winner; and Corey Thorp, Masters runner-up)

The C·I·B's international science advisors, who are members of the Steering Committee, attend each ARM as independent scientific reviewers. Prof. Laura Meyerson (University of Rhode Island, USA) and Dr Piero Genovesi (Institute for Environmental Protection and Research, Rome, Italy and Chair of the IUCN SSC Invasive Species Specialist Group), commented:

> *"The focus of the C·I·B on training the scientists of the future is critically important in highly diverse topics with people in varying stages of education and career. For example, seven 2015 PhD Graduates from C·I·B now work in SANBI, University of [KwaZulu]-Natal, and other organisations. Currently C·I·B is training 14 postdoctoral scholars and dozens of graduate students. C·I·B hosts top-notch post-doctoral researchers who are supported based on a convivial, friendly, exciting collaboration which produces very substantial and novel scientific outcomes. C·I·B practices vertically integrated mentoring giving the faculty, post-doctoral researchers and graduate students the opportunity to work together, learn from each other, and ultimately increasing productivity. The strategy of coupling of annual meetings with workshops brings together global groups of researchers that might not normally interact and as a result, many new projects appear to come out of these meetings."*

Staff, guests and team members at the 2016 Annual Research Meeting held at Stellenbosch University (10-11 November 2016)

Mid-year core team meeting

A mid-year Core Team meeting was held concurrent with the 43rd Annual Research Symposium on the Management of Biological Invasions; the meeting was attended by 18 out of 24 Core team members. The team discussed recent changes to the core team (resignations and admissions), staff responsibilities at the hub, and the support provided to the Core Team, as well as opportunities for public engagement through expos etc. and science highlights (or nuggets). The new plans to produce movie clips and podcasts to aid our public engagement programme were also discussed and received an enthusiastic response from the team and some offers to start producing the first examples. UniVen and UP members reported back on events and plans at their institutions.

4.2.3 Science communication events

Northern hub seminar series

The Northern Hub at University of Pretoria initiated a Friday afternoon seminar series in 2016. So far two seminars have been held, addressing the likelihood of controlling invasive alien plants in fynbos protected areas (Brian van Wilgen, C·I·B) and data limitations that affect prevention of introductions (Katelyn Faulkner, UP). The series will continue through 2017.

Northern hub partners' meeting

In August, the Northern Hub held a workshop on 'Biological invasions in urban areas: understanding the problems and identifying research priorities'. Partners from a range of organisations including three metropolitan municipalities and the Gauteng provincial authority attended and productive discussions were held on current research, urban invasion problems and future priorities.

Fame Lab

In February 2016, fifteen students participated in the Fame Lab competition hosted by the C·I·B and SciSTIP (another DST-NRF funded CoE based at Stellenbosch University) in February 2016. Seven students from the C·I·B and one from SciSTIP took part, together with seven students from other departments and CoEs (e.g. SACEMA). Three students from our heat were chosen to go to the semi-finals in Johannesburg in May 2016 and two (Savannah Nuwagaba and Moleseng Claude Moshobane) were runners up in the final. Contestants had three minutes to present a science topic to a panel of expert judges, using only what they could carry onto the stage with them. The Fame Lab competition began in 2004 and has grown to include 26 countries around the world.

Finalists in the national Fame Lab competition following the heat hosted by the C·I·B and SciSTIP at Stellenbosch University. Three of the finalists were from the SU heat, and two of these were from the C·I·B. SU students and interns: Tashnica Sylvester (second from left), Savannah Nuwagaba (fifth from left) and Moleseng Claude Moshobane (front).

4.2.4 Web-based services

INSTRUMENT	NUMBER OF INTERACTIONS	LINK / HANDLE
Information retrieval and submission system	273 items were submitted to the IRSS	https://ir.sun.ac.za/cib/
Web page	21 235 (up 2.5% from 2015) unique visitors 36710 unique page views	www.sun.ac.za/cib

SA	10 638	50%
USA	3401	16%
UK	1076	5%
Australia	622	3%
Germany	477	2%
Other		24%

INSTRUMENT	NUMBER OF INTERACTIONS	LINK / HANDLE
C·I·B – Facebook	667 likes (followers) in total 70 posts 1134 viewers per post (average) Female 50% Male 49% Largest age group 25-34 (21%)	centreforinvasionbiology
C·I·B – Twitter	1303 total Tweets 113 photos and videos 324 followers	@invasionscience
Iimbovane – Facebook	255 page likes 26 posts 5419 people reached Female 61% Male 37% Largest age group 18-24 (37%)	iimbovaneoutreachproject

Two new sources of social media were added in 2016, namely a C·I·B YouTube channel (https://www.youtube.com/channel/ UCXlIbJvRbOZNUV_pNVBpmJw) and a SoundCloud track (https://soundcloud.com/user-374791551/tracks). To date we have one podcast and one movie clip on the channels, and have plans to submit more as they are created.

4.2.5 Iimbovane Outreach Project

The Iimbovane Outreach Project has been extremely active and has seen a number of highlights in 2016 including winning the award for presenting the best learner workshop in the 'Curriculum' space at SciFest Africa 2016.

"Best Workshop – Curriculum" at SciFest Africa 2016

Through the course of 2016, the Iimbovane team was further involved in a number of events promoting and popularising science and technology. In March 2016, Iimbovane was awarded the prize for "*Best Workshop – Curriculum*" at SciFest Africa 2016. Iimbovane is a regular participant in this, the largest science festival in southern Africa, held in Grahamstown. It is a fun-filled event specially styled to make science and technology accessible and interesting to the public.

Participants in the Iimbovane 'Antastic' workshop identifying ants at SciFest Africa 2016 (Photo credit: Dorette du Plessis)

The team surprised participants of all ages with facts about ants, their important role in ecosystems, and how they get their scientific names. Lubabalo Nonkonyana from Kimberley Boys' High said: "*The show was fantastic! I refreshed some knowledge I know about ants and learnt a lot of knew things about how important ants are to the environment. Thank you to the presenters for the awesome show*".

Western Cape Education Department Science Careers Expo

The project also participated and inspired learners at the Western Cape Education Department (WCED) Science Careers Expo. The project team interacted with approximately 260 learners at the project's exhibit.

Schools visits to partnership schools

Between April and September 2016, the Iimbovane project team visited partnership schools to train Grade 10 learners in biodiversity science and the scientific method. The project team introduced the learners to the theory of biodiversity, but also to the importance of biodiversity in their lives and to the use of neglected fields like taxonomy and morphology. During school visits learners perform field investigations in their school ground by collecting ants in pitfall traps, make use of personal mini-microscopes to investigate morphological differences in ant species, learn to use identification (dichotomous) keys to identify the ants, and analyse their own scientific data. (Each school also has a high-quality dissecting microscope, laptop computer and digital projector donated by Iimbovane; these can be used in the project but also for general use in life science teaching.) In total, the project team interacted with 1100 Grade 10 learners from 28 partnership schools.

Participants in the Iimbovane's 'Big on Biodiversity' workshop. Left: learners exploring fynbos and freshwater ecosystems in the Jonkershoek Nature Reserve, in October 2016. Right: counting and measuring mussels during one of the field studies (Photos: Sophia turner)

Workshops at Stellenbosch University

The Iimbovane Outreach Project also made the most of the school holidays to host two 5-day "*Big on Biodiv*ersity" workshops for learners in June and October. These workshops had the goal of teaching learners about biodiversity in Fynbos ecosystems (both terrestrial and freshwater), biodiversity as indicators of environmental health, biodiversity loss due to invasive alien species and the impacts of invasive alien species on local biodiversity. Training took place through hands-on monitoring and field surveys whereby learners applied the scientific method to do their own projects on biodiversity in the field. They assessed biodiversity, sampled and identified specimens and analysed and presented their data in groups. In the process they learnt to use many new pieces of scientific equipment as well as PowerPoint. A total of 50 learners attended the workshops.

In July 2016, Iimbovane hosted two one-day "*Biodiversity Explorer*" workshops for a group of learners from the Umyezo Wama Apile Combined School in Grabouw, and a group of learners from the Ikamvalethu Secondary School in Langa. Due to these schools' proximity to the Stellenbosch University campus, the project team could invite the whole Life Science class for a unique university experience instead of simply visiting the school grounds. The morning session took the learners to Jan Marais Nature Reserve in the heart of Stellenbosch, where the groups learned about the scientific method, biodiversity monitoring and plant sampling techniques. The afternoon session focused on microscope work, insect identifications and morphology.

Learners from the Umyezo Wama Apile Combined School identifying plant species during a one-day workshop (Photo: Sophia Turner)

Workshop with SANParks junior rangers

SANParks is a key partner of the Iimbovane project, and in 2016, the project team was happy to travel to Karoo National Park, Beaufort West to raise awareness of the importance and diversity of ants among the park's junior rangers. The training session, titled "*Amazing Ants of Karoo National Park*", gave the junior rangers an overview of the significant role that these tiny insects play in ecosystems and how scientists identify different species. The most rewarding moment for the Iimbovane team was when the junior rangers looked at the ants under a microscope for the first time and tried to identify the ants using the information they had received. Some of junior rangers described the "coolest" things they learnt:

> "*I learned that they can lift up to 20 times their weight. I also learned that they have a petiole and* spines."

> "Now *I have a better understanding about the social life of ants and how they interact and communicate with each other*."

Karoo National Park's Junior Rangers learning about different sampling techniques during a one-day workshop presented by the Iimbovane project team (Photo: Dorette du Plessis)

Educational resources

The Iimbovane Outreach Project also developed a learner work book for use in their frequent learner workshops. The work book provides the materials and methods needed to conduct each scientific study in the workshop programme, with the purpose that it will serve as a reference for

learners if they want to repeat the studies back in their own home environments, for example, for a school science project. The work book further provides the learners with a section where they can reflect on each day's activities and make notes about the new skills they learned. These reflections proved to be very valuable for the evaluation of workshops by learners and the project team, and for the learners to remember the skills they acquired.

Take a Girl Child to Work Day

On the 26th May 2016 the Iimbovane Outreach Project participated in the Cell C Take a Girl Child to Work Day. The C·I·B and Iimbovane are regular participants in this annual event that supports the need to expose girls to the realities of the work environment. Four Grade 11 learners, from Weltevrede Secondary School in Wellington joined Iimbovane for a day in life of a C·I·B employee. The day's activities allowed learners to see the variety of roles within an academic institution. Five of the C·I·B's female scientists and administrators each spent half an hour with the girls, giving them a brief outline of their jobs and career path, before passing on some of their pearls of wisdom. The learners saw the life of a researcher, a post-doctoral student, a PhD student, a database manager and the C·I·Bs Deputy Director. From spawning mussels to distinguishing between invasive and native ladybirds, there was never a dull moment. The day also included a tour of the campus and the Stellenbosch University library.

Book chapter

A highlight in 2016 was the Iimbovane Project's mention and contribution to a book chapter in a book titled, *Biodiversity and Education for Sustainable Development*, through Dorette Du Plessis, who was a co-author. The book forms part of Springer's *World Sustainability Series*. The chapter showcased the Iimbovane Outreach Project as a model for successfully bringing practical biodiversity science into the classroom whilst supporting the national Life Science curriculum.

4.2.6 Media highlights

In 2016, the C·I·B's research was reported on in both local and international media. The complete list of media mentions can be viewed in the media interactions section of the report (section A. 4.2). However, there are a few highlights that deserve special mention.

Several papers published by C·I·B Core Team Member John Measey and his students received media attention. One paper, which was published in the *Journal of Applied Ecology*, provided a method for using acoustic monitoring to calculate the number of frogs calling in an area. Articles about this paper featured on online sites including Asia Times and The Conversation. Another paper, which looked at the effects of cannibal frogs on an endangered cousin in the southwestern Cape, led to articles in the newspaper, The Times, and on the online platform, Times Live.

A paper by C·I·B Core Team Member Brian van Wilgen, and colleagues from South African National Parks, CapeNature, and Nelson Mandela Metropolitan University received wide media attention. The paper, published in *Biological Conservation*, reviewed the performance of the Working for Water programme, highlighting that the programme needed to focus resources on areas prioritised for

eradication. The paper has led to articles on several online news platforms including Times Live, IOL Independent News and Cape Times. The paper was also featured in several articles in the print media including Die Burger, Saturday Weekend Argus and Saturday Star. The importance of invasive tree management received further exposure through radio interviews with Prof. Brian van Wilgen and Ross Shackleton on Cape Talk and Radio Today.

In August 2016, a paper by C·I·B Director, David Richardson and 2015 C·I·B Fellow Paul Downey in the journal *AoB Plants*, drew attention from international science media platforms. The paper, which proposes six thresholds that species cross before they become extinct, led to articles on the news sites such as Science News Line, Science Codex, Nature World News, *Scientific American* and Science Daily and a "Dispatch" article in *Frontiers in Ecology and the Environment*.

5 Service provision

5.1 Objectives

The C·I·B strives to be valued for its excellent, evidence-based, reliable, affordable and impartial service and to ensure that clients will always be in a position to follow up on the service they have received in such a way that they derive the full benefit from the C·I·B services available.

Many of the Centre's members provide inputs to policy and management guidelines on a regular basis. Several Core Team Members work closely with initiatives of DEA, and in particular their Natural Resource Management Programmes. Our collaboration with SANBI ensures inputs at all levels to SANBI's Invasive Species Programme. Dr Sabrina Kumschick works closely with DEA and SANBI to develop best-practice methods of risk assessment for invasive species.

5.2 Progress

5.2.1 National Status Report on Biological Invasions in South Africa

The South African National Biodiversity Institute (SANBI) is required by the National Environmental Management: Biodiversity Act (10 of 2004, NEM:BA) to produce a triennial report on the status of invasive alien species in South Africa. The report must contain a summary and assessment of (a) the status of listed invasive species and other species that have been subjected to a risk assessment; and (b) the effectiveness of the regulations and control measures. SANBI is also expected to carry out the research and monitoring necessary to determine status and effectiveness.

South Africa's first status report is due in October 2017, and early in 2016, the C·I·B agreed to collaborate with SANBI to produce the first status report by taking up a mentoring and capacity development role. C·I·B Core Team Member Brian van Wilgen (pictured below with the SANBI drafting team) is providing guidance and mentorship to SANBI staff and guide the development of the report in all of its phases.

The status report will be the first of its kind, as no other country has attempted this before, and there are no examples to guide the development of the report. The report will rely on a wide range of institutions and individuals (experts, academic staff at universities, scientists in research councils,

and government departments and conservation authorities tasked with management) for access to data and for assistance with assessments.

The full list of service provision activities can be found in Appendix A.5.

The SANBI-C·I·B drafting team for the National Status Report. L-R: Dr Tsungai Zengya (C·I·B alumnus), Monica Nguta, Zanele Mnikathi, Dr Sebataolo Rahlao (C·I·B alumnus), Tenda Munyai, Tumelo Morapi, Prof. Brian van Wilgen (C·I·B Core Team Member). Absent: Prof. John Wilson (C·I·B Core Team Member)

6 Gender impact of the Centre's work

Women are 28 % of the core team and 35% of research associate network of the Centre. All of the hub staff are women, and importantly, the all-woman Iimbovane team is a strong role model for inspiring secondary science learners to take up scientific careers. Our student body is 56% female, and 62% of our post-doctoral associates are female. The C·I·B makes a concerted effort to provide an inclusive and friendly yet professional environment where all genders and cultural groups feel comfortable and are able to be productive and grow. These efforts include a range of training events and academic meetings where training takes place. Women consistently perform well in our annual presentation awards (this year five out of six of the winners were women). We have initiated a series of coaching workshops to be started in 2017 which will be open to all new C·I·B students and post-docs; the aim is to improve the level of preparedness of all students entering the C·I·B and make the Centre a more 'student-ready' institution.

7 Governance and organisational structure

7.1 Steering Committee

The Steering Committee is an advisory structure created to guide the advancement of the Centre. In brief, it advises on objectives and approves the Strategic Plan, Annual Business Plans, budgets

and projections presented by C·I·B management. It must discuss and resolve matters of policy that relate to the CoE and approve the Annual Progress Report prior to submission to the NRF. It makes recommendations to the NRF concerning the progress of the Centre and assists in the promotion of, and lobbying for support for, the CoE to facilitate achievement of its objectives and advises on resourcing.

Table 6. The Steering Committee of the C·I·B in 2016

Name	Affiliation	Role
Prof. Eugene Cloete	Vice-Rector, Research, Innovation and Postgraduate Studies, Stellenbosch University	Chair; ex officio
Prof. David Richardson	Director, C·I·B, Stellenbosch University	Ex officio
Prof. Louise Warnich	Dean, Faculty of Science, Stellenbosch University	Ex officio
Dr Makobetsa Khati	Executive Director, Research Chairs and Centres of Excellence (RCCE) Programme	Funder representative
Prof. Laura Meyerson	Professor, Natural Resources Science, University of Rhode Island, USA	Science advisor
Prof. Piero Genovesi	Head of Wildlife Service, ISPRA Institute for Environmental Protection and Research, and Chair IUCN SSC Invasive Species Specialist Group, Italy	Science advisor
Dr Wendy Annecke	General Manager, Cape Research Centre, SANParks Scientific Services	Social science advisor
Prof. John Donaldson	Director, Applied Biodiversity Research Division, SANBI	Industry representative
Prof. Paul Skelton	Emeritus Professor, SAIAB and Rhodes University	Industry representative
Mr Ahmed Khan	Natural Resources Management Programmes, Department of Environmental Affairs	Industry representative
Prof. Michael Somers	Associate Professor, Centre for Wildlife Management, University of Pretoria	Core team representative
Dr Sarah Davies	Deputy Director, C·I·B, Stellenbosch University	Ex officio, staff rep.

7.2 Core team members

Core team members are full-time researchers located in a range of South African institutions, including universities, national regulators and other research organisations. Core team members conduct research, train students and undertake outreach in biological invasions towards the goals of the CoE. The composition of the core team comes under regular review by the C·I·B Steering Committee.

Table 7. C·I·B Core team members in 2016

Name	Institution	Race	Gender	% Time spent working in CoE
Prof. David Richardson	SU	W	M	100
Dr Sarah Davies	SU	W	F	100
Prof. Marcus Byrne	Wits	W	M	10
Prof. Chris Chimimba	UP	B	M	25
Prof. Susana Clusella-Trullas	SU	W	F	50
Prof. Colleen Downs	UKZN	W	F	8
Prof. Karen Esler	SU	W	F	10
Prof. Stefan Foord	UniVen	W	M	20
Dr Llewellyn Foxcroft	SANParks	W	M	20

Name	Institution	Race	Gender	% Time spent working in CoE
Dr Mirijam Gaertner (until Nov. 2016) *	City of CT	W	F	95
Prof. Charles Griffiths	UCT	W	M	20
Prof. Cang Hui	SU	B	M	40
Prof. Steven Johnson (until June 2016)	UKZN	W	M	3
Dr Sabrina Kumschick	SU	W	F	100
Prof. Jaco Le Roux	SU	W	M	50
Dr John Measey	SU	W	M	100
Prof. Mark Robertson	UP	W	M	20
Dr Tammy Robinson	SU	W	F	35
Prof. Mathieu Rouget (until Nov. 2016) #	UKZN	W	M	5
Prof. Michael Somers	UP	W	M	10
Prof. Peter Taylor	UniVen	W	M	20
Prof. John Terblanche	SU	W	M	10
Prof. Brian van Wilgen	SU	W	M	100
Prof. Olaf Weyl	SAIAB	W	M	10
Prof. John Wilson	SANBI	W	M	100

* Dr Gaertner moved to Nürtingen-Geislingen University of Applied Science in Germany; will remain involved with C•I•B work as Research Associate.
# Prof. Rouget moved to La Reunion to take up a position with CIRAD (the French Agricultural Research Centre for International Development). will remain involved with C•I•B work as Research Associate.

7.3 Research associates

The C·I·B's Research Associates are individuals working within academic and non-academic organisations who are expert or interested in matters related to biological invasions. The Research Associate network allows the Centre to extend its influence outside the academic sphere, and to draw on the expertise of a diverse range of skilled personnel. In some cases, the Centre's support for Research Associates also contributes to research capacity development and keeps us in touch with our growing alumnus of graduates and former post-doctoral associates, some of whom occupy influential positions in partner organisations.

Table 8. C·I·B Research Associates in 2016

Full Name	Affiliation
Dr Mhairi Alexander	Lecturer, School of Science and Sport, Department of Applied Bioscience and Zoology, University of West Scotland, UK
Prof. Tim Blackburn	Chair of Invasion Biology, Centre for Biodiversity and Environment Research in Department of Genetics, Evolution and Environment, University College London.
Dr Ryan Blanchard	Ecologist and Senior Researcher, Natural Resources and Environment, CSIR
Dr Jane Carruthers	Private
Prof. Steven Chown	Head, School of Biological Sciences, Monash University, Melbourne, Victoria, 3800, Australia
Prof. Franz Essl	Senior Scientist and Professor, Biodiversity and Nature Conservation, Environment Agency Austria, and Division of Conservation Biology, Vegetation and Landscape Ecology, University of Vienna, Austria
Dr Sjirk Geerts	Lecturer, Dept. Conservation and Marine Sciences, Cape Peninsula University of Technology, Cape Town
Prof. Jan Gilliomee	Research Associate, Dept. Botany and Zoology, Stellenbosch University

Full Name	Affiliation
Dr Patricia Holmes	Biodiversity Management Branch, Environmental Resource Management, City of Cape Town
Prof. Brian Huntley	Private
Ms Ulrike Irlich	Project Manager: Early Detection, Rapid Response (EDRR) Programme, City of Cape Town, South Africa
Dr Charlene Janion-Scheepers	Post-doctoral Fellow, School of Biological Sciences , Monash University, Melbourne, Victoria, Australia
Dr Jesse Kalwij	Senior Researcher, Institute for Ecosystem Research – Geobotany, Kiel University, Germany
Dr Rainer Krug	Private
Prof. Christoph Kueffer	Senior Scientist, Institute of Integrative Biology, ETH Zurich, Switzerland
Dr David Le Maitre	Principal Scientist, Natural Resources and Environment, CSIR
Prof. Melodie McGeoch	Associate Professor, Faculty of Science, Monash University, Australia
Mr Dave Pepler	Private
Prof. Petr Pyšek	Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Czech Republic
Dr Antoinette Veldtman	Regional Ecologist, CapeNature Scientific Services
Dr Nicola van Wilgen	Global Change Scientist, Cape Research Centre, South African National Parks
Dr Darragh Woodford	Lecturer, Department of Animal Plant and Environmental Sciences, Wits University

7.4 Staff employed by the C·I·B

This table shows the support staff, including technical, field and administrative staff, who contribute to the Centre's research, student training and outreach goals.

Table 9: C·I·B staff in 2016

Name	Institution	Position	Race	Gender
Ms Lorraine Cilliers (from Feb. 2016)	SU	PA to the Director	W	F
Ms Karla Coombe-Davis	SU	Database Manager	W	F
Dr Sarah Davies	SU	Deputy Director	W	F
Ms Dorette Du Plessis	SU	Chief Technical Officer: Outreach	W	F
Ms Megan Koordom	SU	Molecular Lab. Manager	B	F
Ms Suzaan Kritzinger-Klopper	SU	Senior Technical Officer	W	F
Ms Christy Momberg	SU	Management Assistant	W	F
Dr Elrike Marais	SU	Project Manager	W	F
Ms Rhoda Moses	SU	Administrative Assistant	B	F
Ms Londiwe Msomi	SU	Education Outreach Officer	B	F
Ms Erika Nortjé	SU	Laboratory Manager	W	F
Ms Sophia Turner	SU	Iimbovane Technical Assistant	W	F
Ms Mathilda van der Vyver	SU	Administrative Officer	W	F
Mrs Chantal Ferreira (until July 2016) #	UP	Technical Officer and Admin. Assistant	W	F

Position supported (50%) at the C·I·B northern hub at University of Pretoria

Please see appendix sections A.2.1 and A.2.2 for student and post-doc information.

8 Stage progress

This CoE is currently in **Stage 6** (2015-2019).

Timeframes

The pending Gate review (Gate 6) shall take place during February or March 2019

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

2015: The Steering Committee met on 18 March and 19 October 2015

2016: The Steering Committee met on 18 March and 27 October 2016

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

2015: Student list provided and entered onto the NRF online system as requested

2016: Student list provided and entered onto the NRF online system as requested

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

2015: Vignettes were published regularly on the C·I·B web site, Facebook page and Twitter feed and sent in batches to the NRF on 1 April, 29 July and 1 November

2016: Vignettes were sent to the NRF on 7 June, 5 July 2016 and 28 Feb 2017

Financial responsibilities

The CoE shall present an audited set of financial statements annually at the March Steering Committee meeting reflecting the financial situation of the CoE during the previous financial year

2015: The 2015 financial statements will be presented at the Steering Committee meeting on 18 March 2016

2016: The 2016 financial statements will be presented at the Steering Committee meeting on 24 March 2017

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

2015: Cash flow statements submitted on a quarterly basis as requested in the CoE Handbook (2014 version)

2016: Cash flow statements submitted on a quarterly basis as requested

Reports due in this Stage

The CoE shall submit an Annual Progress Report by no later than end March each year, including the Stage 6 Gate Review Documentation by no later than March 2018 to be reviewed by the CoE Steering Committee

2015: Annual report for 2015 will be submitted to the Steering Committee on 18 March 2016

2016: Annual report for 2016 will be submitted to the Steering Committee on 24 March 2017

The CoE shall submit a Statement of Compliance by no later than March 2019 referring to Stage 6

2015: The statement of compliance for 2015 will be signed off at its March meeting

2016: The statement of compliance for 2016 will be signed off at its March meeting

Standard Output Targets per annum in the Current Stage

Total number of students supported ≥ 50 on average per annum

2015: 67 students supported

2016: 71 students supported

Women students ≥ 50% of all students on average per annum

2015: Women students 54% of student group

2016: Women students 56% of student group

Black students ≥ 50% of all students on average per annum

2015: Black students 52% of student group

2016: Black students 46% of student group

Number of social science students ≥ 2 on average per annum

2015: Two social science students supported (i.e. registered in the social sciences; several other students and post-doctoral associates engaged in projects that ask socially-relevant questions and use social science methods)

2016: Two social science students supported (Thomas Stielau, MA; Brent Abrahams, PhD)

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

2015: 2.25 years

2016: 2.7 years

Average duration of submitted PhD degrees (post Masters) ≤ 3.5 years at end of stage

2015: 4.4 years

2016: 3.8 Years

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

2015: 4.4 years

2016: None have completed in 2016

Post-doctoral researchers ≥ 10% of all students at end of stage

2015: Post-doctoral associates made up 20% of the students and post-doctoral associates supported

2016: Post-doctoral associates made up 18% of the students and post-doctoral associates supported

Each Core Team Member must undertake at least one scientific review per annum on behalf of the NRF (postal peer review process or panel)

2015: 20 reviews performed

2016: 19 reviews performed

Number of patents ≥ 1

2015: 0

2016: 0

Number of peer reviewed publications ≥ 60 on average per annum

2015: 178

2016: 201

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

2015: 2

2016: 1

Number of peer reviewed publications ≥ 10 with an impact rating of ≥ 4.0 on average per annum

2015: 33

2016: 36

Number of national conference presentations ≥ 20 on average per annum

2015: 41 (2 plenary/keynote, 34 oral, 5 poster)

2016: 38 (6 plenary/keynote addresses, 25 oral, 7 poster presentations)

Number of international conference presentation ≥ 10 on average per annum

2015: 26 (2 plenary/keynote addresses; 22 oral; 2 poster)

2016: 40 (7 plenary/keynote addresses; 26 oral, 7 poster presentations

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

2015: 67 (including co-supervisions and UCT Humanities students)

2016: 58 (including co-supervisions)

Number of local conferences organized ≥ 1 at end of stage

2015: One meeting organised (Conservation in the Cape Floristic Region, 13 April 2015)

2016: Two meetings organised (43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, Goudini Spa, 18-20 May 2016, co-hosted with SANBI

ISP; workshop on 'Biological invasions in urban areas: understanding the problems and identifying research priorities' held at University of Pretoria, 25-26 August 2016, by the Northern Hub)

Number of international conferences organized ≥ 1 at end of stage

2015: Two meetings organised (Evolutionary dynamics of tree invasions: drivers, dimensions, and implications for management; Functional responses as a tool in invasion ecology, 9-10 November 2015)

2016: One meeting organised (Non-native species in urban environments: Patterns, processes, impacts and challenges, Lanzerac, Stellenbosch, 7-9 November 2016)

Special Output Targets for the Current Stage

At least one full CoE team activity per annum

2015: The C·I·B held both a core team meeting (Tuesday 14 July 2015 at SAIAB, Grahamstown) and an Annual Research Meeting (12 and 13 November 2015, at Stellenbosch University). Although a few Core Team Members were unable to attend due to other commitments, both meetings were well-attended.

2016: A mid-year Core Team Meeting was held on 18 May 2016 at Goudini Spa, and 18 members attended (six were not able to attend). The annual research meeting was held on 10 and 11 November at Stellenbosch University and was well attended by the core team, science advisors, students and post docs as well as Research Associates, guests and partners of the Centre.

Successful continuation of Iimbovane outreach project to schools in the WCED region

2015: 28 participating schools (17 rural/11 urban of which 26 are serving previously disadvantaged communities; 18 full participation/10 subscription)

2016: 28 participating schools (17 rural/11 urban of which 26 are serving previously disadvantaged communities; 18 full participation/10 subscription).

9 Conclusion

The C·I·B's research in 2016 addressed a wide range of disciplines, scientific approaches, issues, spatial and temporal scales, and taxa and addresses fundamental issues related to the biological invasions. Seventy-one students were supported, four PhD students graduated, and many of our alumni now occupy positions in universities, business, consultancies, government agencies, NGOs and CBOs.

Our main information brokerage event for 20016 was the 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa which was organised jointly with SANBI's Invasive Species Programme. The symposium focused on knowledge gaps for the National Status Report on Biological Invasion in South Africa which is a key deliverable of SANBI and to which the C·I·B is contributing significantly. C·I·B staff and researchers continue to provide service to the

scientific community as Editors, Associate Editors and members of Editorial Advisory Boards of journals and book series, and serve on a variety of academic and non-academic forums. We participated in many international meetings and projects; these continue to strengthen the global profile of the C·I·B, allow us to benchmark our work, attract leading scientists from around the world to work with us, and open opportunities for our students to gain international experience and exposure. We continued to develop scientists in the designated groups and initiated new measures to make the Centre a more 'student-ready' institution.

Despite successes on many fronts, a turbulent period clearly lies ahead for tertiary education and science in South Africa. Science communication is more challenging than ever, and the expectations of stakeholders are growing. It is worrying that most of our crucial partnerships with key organizations hinge on a few individuals. Staff movements in our partner organisations mean that we continually need to re-focus and redesign our partnerships. Uncertainty about the Centre's sustainability has thwarted progress in building more sustainable partnerships. Clarity on the future of the Centre is urgently needed to allow us to plan effectively to address the many challenges that face South Africa regarding the management of biological invasions.

10 Audited financial statements

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY			
STATEMENT OF FINANCIAL POSITION AT 31 DECEMBER 2016			
	Notes	**2016**	**2015**
		R	**R**
ASSETS			
NON-CURRENT ASSETS		514 942.84	598 631.25
Equipment and vehicles	2	514 942.84	598 631.25
CURRENT ASSETS		12 101 856.26	8 935 033.94
Trade and other receivables	3	4 333.10	191 930.15
Stellenbosch University	4	12 097 523.16	8 743 103.79
TOTAL ASSETS		**12 616 799.10**	**9 533 665.19**
EQUITY AND LIABILITIES			
CAPITAL AND RESERVES		12 479 123.12	9 341 721.20
Accumulated funds		12 479 123.12	9 341 721.20
CURRENT LIABILITIES		137 675.98	191 943.99
Trade and other payables	5	137 675.98	191 943.99
TOTAL FUNDS AND LIABILITIES		**12 616 799.10**	**9 533 665.19**

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER 2016

	Notes	2016	2015
		R	R
Revenue		9 841 937.00	9 373 273.00
Other income		5 720 847.93	3 691 606.32
Operating expenses	7	(13 246 602.20)	(11 901 809.61)
Operating profit		2 316 182.73	1 163 069.71
Finance income		821 789.05	629 906.51
Finance cost		(569.86)	-
Surplus for the year		3 137 401.92	1 792 976.22
Total comprehensive income for the year		**3 137 401.92**	**1 792 976.22**

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 DECEMBER 2016

	2016	2015
	R	R
ACCUMULATED FUNDS		
At the beginning of the year	9 341 721.20	7 548 744.98
Total comprehensive income for the year	3 137 401.92	1 792 976.22
At the end of the year	**12 479 123.12**	**9 341 721.20**

	2016	2015
DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY		
STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 31 DECEMBER 2016		
	R	**R**
CASH FLOWS FROM OPERATING ACTIVITIES		
Net surplus for the year	3 137 401.92	1 792 976.22
Adjustment for:		
Interest received	(821 789.05)	(629 906.51)
Interest paid	569.86	-
Exchange rate loss	2 535.40	135.33
Depreciation	310 869.75	283 017.41
Profit on sale of equipment and vehicles	(97 500.00)	-
Operating profit before working capital adjustments	2 532 087.88	1 446 222.45
Working capital adjustments	130 793.64	(341 117.03)
Decrease/(Increase) in trade and other receivables	187 597.05	(182 494.39)
Decrease in trade and other payables	(56 803.41)	(158 622.64)
Cash generated from operations	2 662 881.52	1 105 105.42
Interest received	821 789.05	629 906.51
Interest paid	(569.86)	-
NET CASH FLOWS FROM OPERATING ACTIVITIES	**3 484 100.71**	**1 735 011.93**
CASH FLOWS FROM INVESTMENT ACTIVITIES		
Equipment and vehicles purchased	(227 181.34)	(211 696.91)
Proceeds on the sale of fixed assets	97 500.00	1 435.01
Increase in amount owed by Stellenbosch University	(3 354 419.37)	(1 524 750.03)
NET CASH FLOWS FROM INVESTMENT ACTIVITIES	**(3 484 100.71)**	**(1 735 011.93)**
NET INCREASE IN CASH AND CASH EQUIVALENTS	-	-
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	-	-
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	**-**	**-**

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016

1. ACCOUNTING POLICY

BASIS FOR PREPARATION

The DST-NRF Centre of Excellence for Invasion Biology ("C I B") is an inter-institutional Centre of Excellence established within the Department of Science and Technology's Centre of Excellence Programme, and is co-funded by the Department of Science and Technology through the National Research Foundation and Stellenbosch University.

Although the CIB is hosted by Stellenbosch University, the CIB conducts research and student training through a distributed network of researchers at seven South African universities and institutions. These include the Universities of Kwazulu-Natal, Cape Town, Pretoria, Venda and the Witwatersrand, and the City of Cape Town, South African National Parks (SANParks), South African Institute for Aquatic Biodiversity (SAIAB) and the South African National Biodiversity Institute (SANBI).

The DST-NRF Centre of Excellence for Invasion Biology Financial Statements, prepared in connection with the Arrangement, present the historical financial position, results of operations in net investment and cash flows of CIB. The CIB Financial Statements have been derived from the accounting records of Stellenbosch University and should be read in conjunction with Stellenbosch University's annual audited Consolidated Financial Statements and the notes thereto for the year ended 31 December 2016. The accounting records of the CIB are maintained within cost centres specifically dedicated to the activities conducted by it. All expenses attributable to the CIB are separately identifiable and are thus accounted for in these cost centres. The CIB Financial Statements thus do not necessarily reflect what the results of operations, financial position, or cash flows would have been had CIB been a separate entity.

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.

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016 (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 TO PUBLISHED STANDARDS APPLIED FOR THE FIRST TIME DURING THE YEAR

Certain new standards, amendments and interpretations relating to existing standards that have become compulsory for the financial year starting on 01 January 2016, have been applied by the centre for the first time. None of these had a material impact on the financial statements. The amendments to and interpretations of the standards are as follows:

Amendments to IFRS 10, 'Consolidated financial statements' and IAS 28,'Investments in associates and joint ventures' (1 January 2016)
Amendments to IFRS 11, 'Joint arrangements' on acquisition of an interest in a joint operation (1 January 2016)
IFRS 14 – Regulatory deferral accounts (1 January 2016)
Amendments to IAS 1,'Presentation of financial statements' disclosure initiative (1 January 2016)
Amendments to IAS 16, 'Property, plant and equipment' and IAS 38,'Intangible assets', on depreciation and amortisation (1 January 2016)
Amendments to IAS 16, 'Property, plant and equipment' and IAS 41, 'Agriculture' on bearer plants (1 January 2016)
Amendments to IAS27, 'Separate financial statements' on equity accounting
Amendments to IFRS 5, 'Non-current assets held for sale and discontinued operations'
Amendments to IFRS 7, 'Financial instruments: Disclosures'
Amendments to IAS19, 'Employee benefits'
Amendments to IAS34, 'Interim financial reporting'

STANDARDS AND AMENDMENTS TO EXISTING STANDARDS NOT YET EFFECTIVE

Certain new standards and amendments to existing standards that have become compulsory for accounting periods commencing on or after 1 January 2017 or later and that the centre has not yet applied, have been published. The centre will apply these in the applicable period, if relevant. The new standards and amendments to existing standards are as follows:

IFRS 15 and amendment to IFRS 15, 'Revenue from contracts with customers' (effective date of 1 January 2018)

IFRS 15 is a single, comprehensive revenue recognition model for all contracts with customers to achieve greater consistency in the recognition and presentation of revenue. Revenue is recognised based on the satisfaction of performance obligations, which occurs when control of the goods or service transfers to a customer.

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016 (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.

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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 TO PUBLISHED STANDARDS APPLIED FOR THE FIRST TIME DURING THE YEAR

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Amendments to IAS34, 'Interim financial reporting'

STANDARDS AND AMENDMENTS TO EXISTING STANDARDS NOT YET EFFECTIVE

Certain new standards and amendments to existing standards that have become compulsory for accounting periods commencing on or after 1 January 2017 or later and that the centre has not yet applied, have been published. The centre will apply these in the applicable period, if relevant. The new standards and amendments to existing standards are as follows:

IFRS 15 and amendment to IFRS 15, 'Revenue from contracts with customers' (effective date of 1 January 2018)

IFRS 15 is a single, comprehensive revenue recognition model for all contracts with customers to achieve greater consistency in the recognition and presentation of revenue. Revenue is recognised based on the satisfaction of performance obligations, which occurs when control of the goods or service transfers to a customer.

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016 (continued)

STANDARDS AND AMENDMENTS TO EXISTING STANDARDS NOT YET EFFECTIVE (continued)

IFRS 16, 'Leases' (effective date 01 January 2019)

The new standard addresses the definition of a lease, recognition and measurement of leases and establishes principles for reporting useful information to users of financial statements about the leasing activities of both lessees and lessors. A key change is that most operating leases will be accounted for on the statement of

Management is currently investigating the impact of these new standards and amendments, but there will not be a material impact on the carve-out annual financial statements of the centre in the following year.

STANDARDS AND AMENDMENTS TO EXISTING STANDARDS WHICH WILL NOT HAVE A MATERIAL EFFECT ON THE ANNUAL FINANCIAL STATEMENTS

Amendments to IFRS 10, 'Consolidated financial statements' and IAS 28,'Investments in associates and joint ventures', on sale or contribution of assets (effective date postponed)
Amendment to IAS 12, 'Income taxes' (effective date of 1 January 2017)
Amendment to IAS 7, 'Cash flow statements' (effective date of 1 January 2017)
Amendments to IFRS 2, 'Share-based payments', on classification and measurement of share-based payment
Amendment to IFRS 9, 'Financial instruments', on general hedge accounting (effective date of 1 January 2018)
Amendments to IFRS9, 'Financial instruments'(2009 & 2010, on financial liabilities, derecognition of financial instruments, financial assets and generel hedge accounting (effective date of 01 January 2018)

CRITICAL ACCOUNTING ESTIMATES AND JUDGEMENTS

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

Useful lives of assets

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

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

2. EQUIPMENT AND VEHICLES

	EQUIPMENT R	VEHICLES R	TOTAL R
31 December 2016			
Carrying amount at the beginning of the year	343 467.45	255 163.80	598 631.25
Cost	3 488 861.94	494 105.01	3 982 966.95
Accumulated depreciation	(3 145 394.49)	(238 941.21)	(3 384 335.70)
Additions during the year	17 509.76	209 671.58	227 181.34
Disposals	-	-	-
Cost	(96 657.30)	(156 313.46)	(252 970.76)
Accumulated depreciation	96 657.30	156 313.46	252 970.76
Depreciation for the year	(194 739.76)	(116 129.99)	(310 869.75)
Carrying amount at the end of the year	166 237.45	348 705.39	514 942.84
Cost	3 409 714.40	547 463.13	3 957 177.53
Accumulated depreciation	(3 243 476.95)	(198 757.74)	(3 442 234.69)

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016 (continued)

2. EQUIPMENT AND VEHICLES (continued)

	EQUIPMENT R	VEHICLES R	TOTAL R
31 December 2015			
Carrying amont at the beginning of the year	331 775.07	339 611.69	671 386.76
Cost	3 168 787.08	494 105.01	3 662 892.09
Accumulated depreciation	(2 837 012.01)	(154 493.32)	(2 991 505.33)
Additions during the year	188 523.42	-	188 523.42
Transfers	23 173.49	-	23 173.49
Cost	157 926.53	-	157 926.53
Accumulated depreciation	(134 753.04)	-	(134 753.04)
Disposals	(1 435.01)	-	(1 435.01)
Cost	(26 375.09)	-	(26 375.09)
Accumulated depreciation	24 940.08	-	24 940.08
Depreciation for the year	(198 569.52)	(84 447.89)	(283 017.41)
Carrying amount at the end of the year	343 467.45	255 163.80	598 631.25
Cost	3 488 861.94	494 105.01	3 982 966.95
Accumulated depreciation	(3 145 394.49)	(238 941.21)	(3 384 335.70)

	2016 R	2015 R
3. TRADE AND OTHER RECEIVABLES		
Trade receivables	-	189 630.50
Other	4 333.10	2 299.65
	4 333.10	191 930.15
The ageing of these receivables are as follows:		
Up to 2 months	4 333.10	191 930.15
	4 333.10	191 930.15

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 2016 was 6.95% (2015: 5.80%). The loan has no fixed terms of repayment. The bank account of Stellenbosch University is also used for the centre's purposes and amounts are transferred between the two entities via loan accounts. This loan account is thus used for this purpose.

5. TRADE AND OTHER PAYABLES		
Leave pay provision	69 053.08	105 789.67
Other creditors	7 080.00	19 961.11
Provision for audit fees	61 542.90	66 193.20
	137 675.98	191 943.98

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016 (continued)

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

	2016 R	2015 R
Audit fees - audit	53 409.90	66 191.64
Depreciation	310 869.75	283 017.41
Foreign exchange loss	3 053.28	1 019.46
Salaries	6 161 280.82	5 074 277.75
Team member research cost	5 389 788.43	5 301 363.66
Other	1 328 200.02	1 175 939.69
	13 246 602.20	11 901 809.61

8. FINANCIAL INSTRUMENTS

Foreign currency management and exposure

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

Liquidity risk

Liquidity is managed by monitoring forecast cash flows.

Credit risk management

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

Cash flow and fair value interest rate risk

As at 31 December 2016 and 2015, 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 R120 975.23 (2015: R87 431.04). The other financial instruments are not exposed to interest rate risk.

Fair values

At 31 December 2016 and 2015 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 R	Contractual cash flows R	< 1 year R	1 - 5 years R	> 5 years R
Financial liabilities					
31 December 2016					
Trade and other payables	137 675.98	137 675.98	137 675.98	-	-
Net financial liabilities	137 675.98	137 675.98	137 675.98	-	-

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2016 (continued)

Financial liabilities (continued)

31 December 2015

	Carrying value	Contractual cash flows	<1 year	1 - 5 years	>5 years
	R	R	R	R	R
31 December 2015					
Trade and other payables	191 943.99	191 943.99	191 943.99	-	-
Net financial liabilities	191 943.99	191 943.99	191 943.99		

Capital risk management

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

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

DETAIL INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2016

	2016 R	2015 R
INCOME	**16 384 573.98**	**13 694 785.83**
National Research Foundation grant	9 841 937.00	9 373 273.00
Other income	4 638 646.05	2 753 395.19
SU contribution	984 184.00	937 327.00
Interest received	821 789.05	629 906.51
Foreign exchange profit	517.88	884.13
Profit on sale of equipment	97 500.00	-
EXPENDITURE	**13 247 172.06**	**11 901 809.60**
Operational expenses	7 085 891.24	6 827 531.85
Advertisements	17 280.00	18 473.83
Audit fees - current year	61 542.90	66 193.20
- previous year over provision	(8 133.00)	(1.57)
Clothing	-	2 055.00
Consumables	30 305.03	13 359.34
Copying and stationery	103 307.61	35 550.13
Depreciation	310 869.75	283 017.41
Entertainment	17 221.43	5 347.20
Foreign exchange loss	3 053.28	1 019.46
Interest paid	569.86	-
Insurance	4 912.63	497.64
Levies	165 313.97	104 901.49
Membership and affiliation fees	-	21 209.50
Non-capitalised books	72 347.90	245.96
Small capital works: not capitalised	35 282.28	36 541.26
Postage, telephone and fax	58 339.08	80 198.61
Rent paid for facilities	225.00	525.00
Repairs	94 913.34	123 235.43
Software and internet	14 638.16	10 381.21
Sponsorships and donations	-	50 000.00
Sundry expenses	6 000.91	13 515.08
Team member research costs	5 389 788.43	5 301 363.66
Transport and accommodation	456 327.99	409 890.33
Workshops	251 784.69	250 012.68
Personnel expenses	6 161 280.82	5 074 277.75
Salaries	6 161 280.82	5 074 277.75
SURPLUS FOR THE YEAR	**3 137 401.92**	**1 792 976.23**

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Appendices: Outputs of 2016

A. 1. Research

A. 1.1 Books

Wilson, J.R., Panetta, F.D. and Lindgren, C. (2016). Detecting and Responding to Alien Plant Incursions. Cambridge University Press. 282pp, ISBN 978-1107479487.

A. 1.2 Book chapters

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Zimmermann, T.G., Andrade, A.C.S. and Richardson, D.M. (2016). Experimental assessment of factors mediating the naturalization of a globally invasive tree on sandy coastal plains: a case study from Brazil. *AoB Plants* **8**, plw042, 16 pages. DOI: 10.1093/aobpla/plw042.

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A. 1.5 Products, artefacts and patents

None in 2016

A. 1.6 Conferences attended

International plenary/keynote addresses

Barton, M., Clusella Trullas, S., Terblanche, J.S. 2016. Modelling insect landscapes under climate change. International Congress of Entomology, Orlando, USA, 2016 (Terblanche)

Esler, K. 2016. Sustained interdisciplinary engagements to address complex social-ecological problems. Scenarios and Models of Biodiversity and Ecosystem Services in Support of Decision-making (SCENNET), Montpelier, France. August 2016 (Esler)

Richardson, D.M. 2016. 3rd international symposium: Tephritid workers of Europe, Africa and the Middle East, Spier, Stellenbosch, April 2016. (Richardson)

Richardson, D.M. 2016. Forest Ecosystems Workshop: Forestry University of Beijing and Beihua University, China. September 2016 (Richardson)

Richardson, D.M. 2016. State of the World's Plants symposium, Kew Gardens, UK: Alien plant invasions and native plant extinctions. May 2016 (Richardson)

Terblanche, J.S. 2016. Diffusion-convection switches in insect respiration. International Congress of Entomology, Orlando, USA, 2016 (Terblanche)

Weyl, O.L.F. 2016. Determining priorities, cutting losses and managing conflicts associated with aquatic invasions: a South African perspective. SELCS, Curitiba, Brazil. October 2016 (Weyl)

Weyl, O.L.F. 2016. Determining priorities, cutting losses and managing conflicts associated with aquatic invasions: a South African perspective. 19th International Conference on Aquatic Invasive Species, Winnipeg, Manitoba, Canada. April 2016 (Weyl).

National plenary/keynote addresses

Richardson, D.M. 2016. Annual conference of the South African Association of Botanists. Plant invasion science: Challenges and opportunities in South Africa. Bloemfontein. January 2016 (Richardson)

Richardson, D.M. 2016. 43rd Annual Research Symposium on the Management of Biological Invasions, Goudini, May 2016, (Richardson)

Richardson, D.M. 2016. Global change impact on diseases and alien species expansion (AIMS) Workshop, Cape Town, May 2016. (Richardson)

Van Wilgen, B.W. 2016. Fynbos Forum, Port Elizabeth. Keynote address – Ecological Research and conservation management in the CFR between 1945 and 2015. (Van Wilgen).

International oral contributions

Barton, M., Clusella Trullas, S., Terblanche, J.S. 2016. Modelling insect landscapes under climate change. International Congress of Entomology, Orlando, USA, 2016. (Terblanche)

Broeckhoven, C., du Plessis, A., le Roux, S. G., Mouton, P. le F. N. and Hui, C. 2016. A non-invasive protocol for in vivo micro-CT imaging of lizards. 8th World Congress of Herpetology, Hangzhou, China, 15-21 August 2016. (Hui)

Clusella-Trullas, S. 2016. Can reptiles buffer climate change through behaviour? 8th World Congress of Herpetology, 15-21 August 2016, Hangzhou, China. Invited speaker for the symposium

entitled "Ecology and Physiology of Amphibians and Reptiles: Challenges Caused by Global Climate Change". (Clusella-Trullas)

Esler, K. 2016. South Africa: scenarios and ecological restoration. ScenNet Workshop on Scenarios and models of biodiversity and ecosystem applied to landscape restoration. SPaventura Ecolodge, Sao Paulo State, Brazil, November 2016 (Esler)

Foord, S.H., Dippenaar-Schoeman, A.S. The effect of elevation and time on mountain spider diversity: a view of two aspects in the Cederberg mountains of South Africa. 20th International Congress of Arachnology. Colorado School of Mines, Golden, Colorado, USA, July 2-9, 2016. (Foord)

Foxcroft, L.C., Novoa, A., Le Roux, J.J., Herbst, M. 2016. Impacts of Opuntia stricta on biodiversity, ecosystem function and social perceptions, in Kruger National Park. 14th Annual International Savanna Science Networking Meeting, March 2016 (Foxcroft)

Gaertner, M. Novoa, A., Fried J., Larson, B. M.H., Richardson, D.M. Managing invasive species in cities: A framework applied to Cape Town. International Workshop: 'Non-native species in urban environments: patterns, processes, impacts and challenges', Lanzerac, Stellenbosch, South Africa, November 2016 (Gaertner)

Gallien, L., Landi, P., Richardson, D.M., Hui, C. 2016. Evolution of intransitive competition. British Ecological Society Annual Meeting, Liverpool (Hui, Richardson)

Kumschick S (2016) Alien species classification and missing data: impact matters. Neobiota: 9th international conference on biological invasions. Vianden, Luxembourg. 14 September (Kumschick)

Landi, P., Vonesh, J., Hui, C. 2016. Adaptive dynamics of life-history switch-point phenotype explain across- and within-population variability. Ecological Society of America Annual Meeting, Fort Lauderdale (Hui)

Mabin CA, Wilson JR, Le Roux JJ, Sink KJ, Robinson TB. Controlling *Carcinus maenas* in South Africa, is eradication feasible or desirable? 9th International Conference on Marine Bioinvasions, Sydney Australia, January 2016 (Robinson)

Mauda, E.V., Munyai, T.C., Foord, S.H. Ant and Spider diversity in a rural landscape of the Vhembe Biosphere, South Africa. Australian Entomological Society 47th AGM and New Zealand Entomological Society. Ridges at Swanston Hotel, Melbourne, Australia, 27 November- 01 December 2016. (Foord)

Measey, J. 2016. Publishing Herpetological Journal Articles in a Globalized World. 8th World Congress of Herpetology, Hangzhou, China, August 2016 (Measey)

Measey, J. De Villiers, A. 2016. Overland movement of *Xenopus laevis* in southern Africa, and its implications to invasions. 8th World Congress of Herpetology, Hangzhou, China, August 2016 (Measey)

Measey, J., Stevenson, B., Scott, T., Altwegg, R. Borchers, D. Counting chirps: acoustic monitoring of cryptic frogs. 8th World Congress of Herpetology, Hangzhou, China, August 2016 (Measey)

Measey, J., Vimercati, G., de Villiers, A., Mokhatla, M., Davies, S., Thorp, C., Rebelo, A., Kumschick, S. 2016. A global assessment of alien amphibian impacts in a formal framework. 8th World Congress of Herpetology, Hangzhou, China, August 2016 (Measey)

Modiba, R.V., Foord, S.H. Rifilwe Modiba (Student): The impact of riparian alien plant removal on aquatic invertebrate communities in the upper reaches of Luvuvhu river catchment, Limpopo province. Ridges at Swanston Hotel, Melbourne, Australia, 27 November- 01 December 2016. (Foord)

Nembudani, L. N., Taylor, P. J. and Swanepoel, L. H. 2016. Response of rodents to land use gradients in small-holder croplands/rangelands in Northern Limpopo: Implications for Ecologically-Based Rodent Management. Mini-conference, StopRats Final Meeting, Arusha, Tanzania. 1-2 December 2016. (Taylor)

Peters, K., Sink, K., Robinson, T.B. Raising the flag on marine alien fouling species. 9th International Conference on Marine Bioinvasions, Sydney Australia, January 2016 (Robinson)

Ramanantoanina, A., Hui, C. 2016. Modelling spread of species with habitat dependent growth and dispersal in heterogeneous landscapes, South African symposium of Numerical and Applied Mathematics. (Hui)

Richardson, D.M. 2016. PhragNet Workshop, Italy April 2016 (Richardson)

Robinson, T.B., Alexander, M.E., Simon, C.A., Griffiths, C.L., Peters, K., Sibanda, S., Miza, S., Groenewald, B., Majiedt, P., Sink, K.J. 2016. Lost in translation? Standardising the terminology used in marine invasion biology. 9th International Conference on Marine Bioinvasions, Sydney, Australia, January 2016

Swanepoel, L H. and Taylor, P. J. 2016. Potential and human perceptions of biological control of rodent pests in rural villages in northern South Africa. 5th International Ecosummit Conference. Ecological Sustainability –Engineering Change. 29 August –1 September 2016, Montpellier, France.

Taylor, P. J., Foord, S.H., Gras, I., Linden, V., Weier, S., Maphote, T., Lauer, F. P. M., Tsharntke, T. 2016. Ecosystem services of bats and ants in subtropical fruit crops in southern Africa. 5th International Ecosummit Conference: Ecological Sustainability –Engineering Change. 29 August –1 September 2016, Montpellier, France.

Taylor, P. J., Linden, V. Weier, S. Grass, I., Alberts, D., Tscharntke, T. Ecosystem services of bats and ants in macadamia orchards in South Africa. 17th International Bat Research Conference, Durban, June 2016

Terblanche, J.S. 2016. Diffusion-convection switches in insect respiration. International Congress of Entomology, Orlando, USA, 2016.

Vimercati, G., Davies, S., Measey J. 2016. Never underestimate your opponent: adaptive phenotypic response in a recent invader. Neobiota - 9th International Conference on Biological Invasions, Vianden, Luxembourg, September 2016

National oral contributions

Bellingan, T.A., Woodford, D.J., Villet, M.H.V., Gouws, J., and Weyl, O.L.F. 2016. The effect of consecutive rotenone treatments on the invertebrate fauna of the Rondegat River, Western Cape, South Africa. South African Society of Aquatic Science Conference. 27-30 June, 2016, Skukuza, South Africa. June 2016

Clusella-Trullas, S., Garcia, R. 2016. Impacts of alien vegetation on animal diversity in South Africa: a synthesis. 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, 18-20 May 2016, Worcester, Western Cape Province, South Africa

Dalu, T., Weyl, O.L.F., Froneman, P.W. and Wasserman, R.J. 2016. Understanding changes in ephemeral pond trophic structure in relation to hydroperiod. Southern African Society of Aquatic Scientists Conference, 26-29 June 2016, Skukuza, South Africa. Poster presentation. Oral presentation. June 2016

Esler, K.J., Potts, A., Midgley, G., Cowling, R. 2016. Resourcescapes: what, why, when, how? Fynbos Forum, Port Elizabeth, July 2016

Foord, SH, Modiba, RW. Invertebrate diversity in response to the removal of alien invasive plants in the Luvuvhu river catchment: indications of recovery. 43rd Annual Research Symposium on the Management of Biological Invasions 18 – 20 May 2016, Goudini Spa, near Worcester, Western Cape

Foxcroft, L.C., van Wilgen, N., Cheney, C., van Wilgen, B.W., Baard, J., Cole, N. Biological invasions in South Africa's National Parks. 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, May 2016

Gaertner, M., Richardson, D.M., Cadotte, M., Rouget, M., MacIvor, S., Wilson, J.R.U., Kueffer, C. CT 2016. "Non-native species in urban environments: Patterns, processes, impacts and challenges", Lanzerac, Stellenbosch, November 2016

Garcia, R., Clusella-Trullas, S. 2016. Shade or shun? Effects of plant invasions on native reptiles and amphibians under a warming climate. 43rd Annual Research Symposium on the

Management of Biological Invasions in South Africa, 18-20 May 2016, Worcester, Western Cape Province, South Africa.

Kumschick S (2016) Towards a global classification of alien taxa according to their impacts. Workshop Global change impact on diseases and alien species. African Institute for Mathematical Sciences, Muizenberg, South Africa: 3 May 2016

Mabin CA, Wilson JR, Le Roux JJ, Sink KJ, Robinson TB. Controlling *Carcinus maenas* in Hout Bay harbour: the first attempted management of a marine invasive species in Africa. 43rd Annual Symposium on Management of Biological Invasions, May 2016

Maseko, M., Kalle, R., Ramesh, T. and Downs, C.T. 2016. The effects of habitat modifications and fragmentation on forest bird's occupancy and diversity within the eThekwini Municipality7th annual Oppenheimer De Beers Group Research Conference, Johannesburg

Measey, J., Davies, S., Vimercati, G., Rebelo, A., Schmidt, W. 2016 Invasive amphibians of southern Africa. 43rd Annual Research Symposium on the Management of Biological Invasions, Worcester, South Africa, May 2016

Ndaleni, P.M., Wasserman, R.J., Ellender, B.R., Weyl, O.L.F. 2016. Dam driven invasions of an Eastern Cape River. Southern African Society of Aquatic Scientists Conference, 26 - 30 June 2016, Kruger National Park, South Africa. June 2016

Nunes AL, TA Zengeya, GJ Measey, A Hoffman, L Coetzer, Weyl, OLF. 2016. The invasive Australian redclaw crayfish (*Cherax quadricarinatus*) in South Africa. Southern African Society of Aquatic Scientists, Skukuza, South Africa, June 2016

Nunes AL, TA Zengeya, GJ Measey, OLF Weyl 2016. Freshwater crayfish invasions in South Africa. 43rd Annual Research Symposium on the Management of Biological Invasions, Worcester, South Africa, May 2016

Pillay, K., Ramesh, T., and Downs, C.T. 2016. Aspects of the ecology of feral cats in urban Pietermaritzburg, South Africa. 7th annual Oppenheimer De Beers Group Research Conference, Johannesburg

Robinson TB, Brooker B, Moloney CL. Invasions within South Africa's Marine Protected Areas network. 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, Goudini Spa, South Africa, May 2016

Sikutshwa, L., Evans, B, Measey, J. 2016. Phylogeography of African clawed frogs in southern Africa. Southern African Society of Aquatic Scientists, Skukuza, South Africa, June 2016

Van Wilgen, B.W. 43rd Annual Research Symposium on the management of biological invasions, Goudini Spa, South Africa. Member of the Scientific Organizing Committee. Co-author of eight presented papers.

Wasserman, R.J., Dalu, T., Weston, M., Froneman, P.W., Welch, R.J., Mlambo, M. and Weyl, O.L.F. 2016. Increased male copepod vulnerability to predation in arid ephemeral aquatic environments. Southern African Society of Aquatic Scientists Conference, 26-29 June 2016, Skukuza, South Africa. Poster presentation. Oral presentation. June 2016

Weyl, O.L.F., Ellender, B.R., Wasserman, R.J., Marr, S.M., Ivey, P., Woodford, D.J., Alexander, M., Zengeya, T., Jordaan, M., and Impson, N.D. 2016. Alien fishes: do we know enough for effective management? 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, Worcester. April 2016

Wilson, J.R. 2016. A national status report on biological invasions in South Africa: what do we need to do and what should we do? 43rd Annual Research Symposium on the Management of Biological Invasions, Goudini Spa, Western Cape, 18–20 May.

Woodford DJ, Ivey P, Weyl OLF, Jordaan M, Zengeya T. 2016. A review of the current legal status and management options for invasive fishes in South Africa. 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, Worcester. April 2016

Zengeya T., Ivey P., Woodford D., Weyl O.L.F., Richardson D.M., Van Wilgen B.W., Downs C. 2016. Management of conflict invasive species in South Africa: Challenges and Trade-Offs. 43rd

Annual Research Symposium on the Management of Biological Invasions in South Africa, Worcester. April 2016

Zungu, M., Maseko, M., Kalle, R., Ramesh, T., Rouget, M. and Downs, C.T. 2016. Effects of habitat fragmentation on forest mammal occupancy and ecological connectivity in eThekwini Municipality 7th annual Oppenheimer De Beers Group Research Conference, Johannesburg (Downs).

International posters

Linden, V., Weier, S., Grass, I., Tscharntke, T., Taylor, P.J. How bat and bird communities affect insect damage of macadamia trees. 17th International Bat Research Conference, Durban, June 2016.

Mauda, E.V., Munyai, T.C., Foord, S.H. Ant and Spider diversity in a rural landscape of the Vhembe Biosphere, South Africa. Australian Entomological Society 47th AGM and New Zealand Entomological Society. Ridges at Swanston Hotel, Melbourne, Australia, 27 November- 01 December 2016.

Nunes A.L., T.A. Zengeya, G.J. Measey, O.L.F. Weyl (2016) Freshwater crayfish invasions in South Africa. Neobiota - 9th International Conference on Biological Invasions, Vianden, Luxembourg, September 2016

Pope, H.R., Alexander, A.E., Robinson, T.B. Filtration, feeding behaviour and their implications for future spread: a comparison of an invasive and native barnacle in South Africa. International Conference on Marine Bioinvasions, Sydney, Australia, January 2016

Richards, L.R., Taylor, P., Monadjem. A. The utility of geometric morphometric data in delimiting species within the afrotropical *Hipposideros caffer-ruber* complex (Chiroptera: Hipposideridae). 17th International Bat Research Conference, Durban, June 2016

Sibiya, T.E., Foxcroft, L.C., Esler, K.J. 2016. Riparian plant community change and alien invasion following geomorphological restructuring in the Sabie River, KNP. 14th Annual International Savanna Science Networking Meeting, March 2016

Weier, S.M., Linden, V.M.G., Gaigher, I., White, P.J.C. and Taylor, P.J. Changes of bat species composition over altitudinal gradients on northern and southern aspects of the Soutpansberg mountain range, South Africa. 17th International Bat Research Conference, Durban, June 2016.

National posters

Ramulifho, P.A., Foord, S.H. Environmental Flow Requirements and Response of Macroinvertebrate populations in the Luvuvhu River basin. First International Long-Term Ecological Research, Open Science Meeting. Skukuza, Kruger National Park, South Africa, 9-13th October, 2016. (Foord)

Ramulifho, P.A., Foord, S.H. The long-term variability analyses of flow and water temperature regimes in the Luvuvhu River catchment. Third National Conference on Global Change 2016. Southern Sun and Maharani Hotel, Durban, South Africa, 5-8th December, 2016. (Foord)

Mauda, E.V., Munyai, T.C., Foord, S.H. Ant and Spider diversity in a rural landscape of the Vhembe Biosphere, South Africa. 3rd Global Change Conference. UKZN, South Africa, 05-08 December 2016. (Foord)

Muluvhahothe, M.M., Munyai, T.C, Foord, S.H. A trait-based approach in understanding ant community assembly in the Soutpansberg Mountain, South Africa. 3rd Global change conference. UKZN, South Africa, 05-08 December 2016. (Foord)

Wasserman, R.J., Alexander, M.E., Barrios-O'Neill, D., Weyl, O.L.F. and Dalu, T. 2016. Using functional responses to assess predator hatching phenology implications for pioneering prey in arid temporary pools. Southern African Society of Aquatic Scientists Conference, 26-29 June 2016, Skukuza, South Africa. Poster presentation. June 2016 (Weyl)

Bloy, L.E., Ellender, B.R., Hannweg, B., Weyl, O.L.F. 2016 Assessment of native and non-native fish invasion fronts. South African Society of Aquatic Scientists Conference, 26-30 June 2016, Skukuza, Kruger National Park, South Africa. June 2016 (Weyl)

Hannweg, B., Bloy, L.E., Weyl, O.L.F. 2016. A comparison of sampling techniques for headwater fish surveys. Southern African Society of Aquatic Scientists Conference, 26-30 June 2016, Kruger National Park, South Africa. June 2016 (Weyl).

A. 2. Education and training

A. 2.1 Students supported by the Centre in 2016

Name	Citizenship	Institution	Race	Gender	Status	Funding level*
BSc (Honours)/4th year BAgric.						
Anna Basson	SA	SU	White	F	Completed	Independent
Pumla Dlamini	SA	UKZN	Black	F	Completed	Full
Alistair Galloway	SA	SU	White	M	Completed	Independent
Nicolene Hellstrom	SA	SU	White	F	Completed	Independent
Refilwe Matlhabe	SA	UKZN	Black	F	Completed	Independent
Vhutali Nelwamondo	SA	UP	Black	M	Completed	Partial
Selwyn Roberts	SA	UCT	White	M	Completed	Full
Dineshen Singh	SA	UKZN	Indian	M	Completed	Independent
Hendre van Rensburg	SA	SU	White	M	Completed	Independent
Masters						
Brent Abrahams	SA	SU	Coloured	M	Upgraded	Full
Luca Afonso	SA	SU	White	M	Continuing	Independent
Patricia Begwa	SA	UNW	Black	F	Continuing	Full
Casey Broom	SA	SU	White	M	Completed	Independent
Susan Canavan	Ireland	SU	White	F	Upgraded	Independent
Debbie Du Preez	SA	NMMU	White	F	Continuing	Partial
Zishan Ebrahim	SA	SU	Coloured	M	Completed	Independent
Hermina Fourie	SA	UP	White	F	Completed	Full
Silindile Gumede	SA	UKZN	Black	F	Continuing	Independent
Llewellyn Jacobs	SA	SU	Coloured	M	Completed	Independent
Jacques Jansen van Rensburg	SA	SU	White	M	Completed	Independent
Natasha Kruger	SA	UNW	White	F	Completed	Partial
Asiashu Lithole	SA	UP	Black	F	Completed	Independent
Marike Louw	SA	SU	White	F	Continuing	Full
Nkoliso Magona	SA	SU	Black	M	Continuing	Independent
Ndivhuwo Maligana	SA	UP	Black	F	Continuing	Full
Joy Mangachena	Zimbabwe	CPUT	Black	F	Completed	Independent
Mashudu Mashau	SA	SU	Black	M	Resigned	Independent
Phil McLean	SA	SU	White	M	Completed	Independent
Phumza Ndaleni	SAU	Rhodes	Black	F	Completed	Full
Khensani Nkuna	SA	SU	Black	F	Continuing	Independent
Mlungele Nsikani	Zimbabwe	SU	Black	M	Continuing	Independent
Sinazo Ntsonge	SA	Rhodes	Black	F	Continuing	Independent
Elizabeth Opperman	SA	SU	White	F	Continuing	Full
Mmatsawela Ramahlo	SA	UP	Black	F	Continuing	Full
Alexander Rebelo	SA	SU	White	M	Completed	Independent
Cavin Shivambu	SA	UP	Black	M	Continuing	Independent
Thabang Sibiya	SA	SU	Black	F	Continuing	Independent
Lisa Skein	SA	SU	White	F	Continuing	Full
Thomas Stielau	SA	UCT	White	M	Continuing	Independent
Corey Thorp	SA	SU	White	M	Completed	Independent
Marliese Truter	SA	UNW	White	F	Continuing	Full
Mark Turnbull	SA	UJ	White	M	Completed	Independent
Gareth Walker	SA	SU	White	M	Completed	Independent

Name	Citizenship	Institution	Race	Gender	Status	Funding level*
Georgina Wilson	SA	UP	White	F	Continuing	Independent
PhD-Upgrade						
Brent Abrahams	SA	SU	Coloured	M	Continuing	Independent
Susan Canavan	Ireland	SU	White	F	Continuing	Independent
Stuart Hall	SA	SU	White	M	Continuing	Independent
PhD						
Karla Alujevic	Croatia	SU	White	F	Continuing	Independent
Antoine Bahizi	Rwanda	SU	Black	M	Continuing	Independent
Terence Bellingan	SA	Rhodes	White	M	Completed	Independent
Maria Castillo	Chile	SU	White	F	Continuing	Independent
Chrispian Cheney	SA	SU	White	M	Continuing	Independent
Genevieve Diedericks	SA	SU	White	F	Continuing	Full
Rolanda Julius	SA	UP	Coloured	F	Continuing	Full
Clova Jurk	UK	SU	White	F	Continuing	Partial
Siviwe Lamani	SA	SU	Black	F	Resigned	Full
Sandra MacFadyen	SA	SU	White	F	Continuing	Independent
Lerato Maimela	SA	UP	Black	F	Continuing	Partial
Ingrid Minnaar	SA	SU	White	F	Continuing	Independent
Lubabalo Mofu	SA	Rhodes	Black	M	Continuing	Partial
Nitya Mohanty	India	SU	Indian	M	Continuing	Independent
Mohlamatsane Mokhatla	SA	SU	Black	M	Continuing	Independent
Desika Moodley	SA	UKZN	Indian	F	Completed	Independent
Jeanne d'Arc Mukarugwiro	Rwanda	Wits	Black	F	Continuing	Full
Savannah Nuwagaba	Uganda	SU	Black	F	Continuing	Independent
Koebraa Peters	SA	SU	Coloured	F	Continuing	Partial
Luke Potgieter	SA	SU	White	M	Continuing	Independent
Davina Saccaggi	SA	SU	White	F	Continuing	Independent
Saachshaini Sadchatheeswaran	Canada	UCT	Coloured	F	Continuing	Independent
Likho Sikutshwa	SA	SU	Black	F	Resigned	Partial
Giovanni Vimercati	Italy	SU	White	M	Completed	Full

* Funding is categorised as full (fully supported with bursary and running costs supplied at standard CoE levels), partial (in the form of a partial or full bursary, running costs only) and independent (funding from another source, but supervised by a Core Team Member and using Centre resources).

A. 2.2 Post-doctoral associates supported

Post-doctoral associates are early career researchers engaged on (generally two-year) fellowships to focus on research deliverables such as peer-reviewed publications, organizing workshops and journal special issues, and often play a key role in student training.

Name	Citizenship	Institution	Race	Gender	Status	Funding level*
Jessica Allen	SA	SU	White	F	Resigned	Independent
Thomas Bishop	UK	UP	White	M	Continuing	Independent
Katelyn Faulkner	SA	UP	White	F	Continuing	Independent
Jennifer Fill	USA	SU	White	F	Continuing	Independent
Laure Gallien	France	SU	White	F	Continuing	Full
Raquel Garcia	Portugal	SU	White	F	Continuing	Full
Heidi Hirsch	Germany	SU	White	F	Continuing	Independent
Michael Logan	USA	SU	White	M	Resigned	Independent
Sean Marr	SA	SAIAB	White	M	Continuing	Independent
Ana Novoa Perez	Spain	SU	White	F	Continuing	Independent
Ana Luisa Nunes	Portugal	SU	White	F	Continuing	Independent
Melissa Plasman	Netherlands	SU	White	F	Continuing	Independent
Ross Shackleton	SA	SU	White	M	Resigned	Independent
Jeremy Shelton	SA	SU	White	M	Continuing	Independent

Name	Citizenship	Institution	Race	Gender	Status	Funding level*
Ryan Wasserman	SA	SAIAB	White	M	Resigned	Independent
Florencia Yannelli Lucero	Argentina	SU	White	F	Continuing	Independent

*Funding is categorised as full (fully supported with bursary and running costs supplied at standard CoE levels), partial (in the form of a partial or full bursary, running costs only) and independent (funding from another source, but supervised by a Core Team Member and using Centre resources).

A. 3. Networking

A. 3.1 Academic visitors to Core Team Members

Dr Ara Monadjem, Department of Biological Sciences, University of Swaziland. Collaborator on small mammal ecology (Chimimba)

Dr Ben Stevenson, School of Mathematics and Statistics, Centre for Research into Ecological and Environmental Modelling, University of St Andrews. Acoustic monitoring of frogs (Measey)

Dr Daniel Barthelemy - head of 'BIOS', department of CIRAD, France (Richardson)

Dr J.Venter, Nelson Mandela Metropolitan University (Downs)

Dr Kate Parr, University of Liverpool. Collaborator on Sani Pass ant diversity project. (Robertson)

Dr Lauren Hallett - University of Colorado at Boulder, USA (Richardson)

Dr Marc Rius – University of Southampton, UK (Richardson, Robinson)

Dr Myla Aronson - Rutgers University, Department of Ecology, Evolution and Natural Resources (Gaertner, Richardson)

Dr R. Kalle, Nalanda University, Rajgir, India (Downs)

Dr Roberto Kiesling (retired), Argentina. Collaboration on Cactus Taxonomy (Wilson)

Dr Tsungai Zengeya, SANBI, Kirstenbosch, Cape Town. Collaborator on aquatic ecology (Chimimba)

Ms Catherina Karlsson National University of Singapore, Department of Biological Sciences (Theoretical Ecology and Modelling lab). Acoustic monitoring of frogs (Measey)

Prof. Fernando Ojeda - University of Cadiz, Spain, regarding the biogeography of *Aspalathus* work (Richardson)

Prof. Ilya Raskin, Rutgers University, Global Institute for BioExploration. Collaborator on assessing changes in biochemical and functional profile of secondary metabolites of invasive alien plants (Foxcroft)

Prof. James R. Vonesh, Virginia Commonwealth University, USA (Downs)

Prof. Jay Stauffer, Pennsylvania State University, PA, USA. Collaborator on African Great Lakes research (Weyl)

Prof. Michael Wingfield – University of Pretoria (Richardson)

Prof. Petr Pyšek, The Czech Academy of Sciences, Institute of Botany and Charles University. Collaborator on determinants of distribution patterns and spread of plant invasions in Kruger National Park (Foxcroft)

Prof. S. Andersson University of Gothenburg, Sweden (Downs)

Prof. Tigga Kingston, Texan Technical University, collaborator on ecosystem services of bats, gave a seminar at University of Venda on 12 August 2016 on "Perish or persist? The ecology of vulnerability in Southeast Asia's modified landscapes" (Taylor)

Students of Prof. N. Farwig Philipps, University of Marburg, Germany (Downs)

A. 3.2 Academic visits by Core Team Members to other institutions

BioProtection Research Centre, Lincoln University, Lincoln, New Zealand. Sabbatical research visit to Prof. Phil Hulme's lab (Le Roux)

Cambridge University, UK, Invited participant, workshop on "The Future of Invasion Science", September 2016 (Richardson)

Centre for Ecology, Evolution and Environmental Changes, University of Lisbon, Portugal. Visit Prof. Cristina Máguas in November 2016 (Richardson)

COST Action workshop Prioritisation of Birds and Animals Workshop, Průhonice, Czech Republic 1-2 March 2016 with Prof. Petr Pyšek; Prof. Tim Blackburn and other (Wilson; Kumschick)
Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice, and Charles University in Prague, Czech Republic (Wilson)
Diversity and Spatial Ecology Research Group, Institute of Zoology, Chinese Academy of Sciences (Measey)
European Forest Institute (EFI), Central European Office, Switzerland. Collaboration on the production of guidelines for managing alien and invasive trees in Europe (van Wilgen).
Haramaya University, Addis Ababa, Ethiopia. Collaboration on the ecology and management of woody invasive alien plants species (van Wilgen)
Instituto de Investigacao Pesquera, Moizambique. Collaboration on underwater video analysis with Mr Antonio Pegado (Weyl)
Museum National d'Histoire Naturelle, Paris. Assisted PhD student A. Nengovhela with collections-based research at the Paris Museum and discussed various ongoing collaborations on rodents with Prof. Christiane Denys, including our joint co-writing of the murid rodents chapter of the planned Lynx publication on Mammals of the World (Taylor)
Natural History Museum, London. Collaboration with Dr Jeff Streicher: Does behaviour mediate evolutionary trajectories to climate adaptation? (Clusella-Trullas)
Prof. Jean Vitule, Universidade Federal do Parana. Collaborator fish invasions. (Weyl)
SANParks Scientific Services, Kruger National Park, Skukuza. Collaboration on an alien species Risk Analysis Framework for South Africa with Llewellyn Foxcroft (Kumschick)
SANParks Scientific Services, Kruger National Park, Skukuza. Collaboration on fire research, and on research into the effectiveness of management of invasive alien species (van Wilgen)
Tanzanian Forestry Research Institute, Amani, Tanzania. Collaboration on the ecology and management of woody invasive alien plants species (van Wilgen)
Université de la Réunion, La Reunion, France. Teaching course on risk analysis of alien species with Dominique Strasberg and Brian van Wilgen (Kumschick)
University College, Dublin. Presented a seminar on my bat ecosystem services research to Prof. Emma Teeling and her lab students and postdocs and discussed potential collaboration around bat conservation, ecosystem services and genomics (Taylor)
University of Basel, Switzerland. Presented work on impact classification for alien taxa and discussed potential future collaboration with Brigitte Braschler (Kumschick)
University of Bern, Switzerland. Presented work on impact classification for alien taxa and discussed ongoing and future collaboration with Wolfgang Nentwig (Kumschick)
University of Canberra, Australia, Member of International Panel to review the Institute for Applied Ecology, July 2017 (Richardson)
University of Toronto, Scarborough. Collaboration on novel detection techniques with Dr Nicholas Mandrak (Weyl)
Western Kentucky University. Collaboration on Fish Invasions with Dr Philip Lienesh, (Weyl)

A. 3.3 Travel awards to Core Team Members, post-doctoral associates and students

Ecodry travel award for Dr A. Novoa to visit Coventry University, UK (Wilson)
HB Thom travel award to Prof. J.J. Le Roux for sabbatical research visit at the BioProtection Research Centre, Lincoln University, Lincoln, New Zealand (Le Roux)
Neobiota travel award for G. Vimercati to attend Neobiota 9th International Conference on Biological Invasions meeting in Vianden, Luxemburg (Davies, Measey)
NRF funding for Prof. C. Downs to attend PAOC in Dakar, Senegal Oct 2016 (Downs).
NRF KIC travel award for Dr S. Kumschick to attend Neobiota conference in Vianden, Luxembourg (Kumschick)
Overseas Conference Grant (OCG) from the Postgraduate International Office (PGIO), Stellenbosch University for G. Vimercati to attend Neobiota 9th International Conference on Biological Invasions meeting in Vianden, Luxemburg (Davies, Measey)

SCENNET Project awarded two travel grants to Prof. K.J. Esler to attend to present a plenary at 1) the international conference "Scenarios and Models of Biodiversity and Ecosystem Services in Support of Decision-making", 24-26 August, Montpelier, France and 2) and the international workshop on Scenarios and models of biodiversity and ecosystem applied to landscape restoration, 6-11 November, Sao Paulo, Brazil (Esler)

Stellenbosch University Division, Research Development and Innovation research travel fund award for Dr A. Novoa to visit Coventry University, UK and Prague, Czech Republic (Wilson).

A. 3.4 Research collaborations

Acoustic monitoring. Collaborators: Prof. Res Altwegg, Department of Statistical Sciences, University of Cape Town, South Africa; and Dr David Borchers, School of Mathematics and Statistics, University of St Andrews, Scotland (Measey)

Alien Parasites. Collaborator: Prof. Nico Smit, North West University (Weyl)

Alien plant distribution in protected areas and evidence based management. Collaborator: Prof. Melodie McGeoch, School of Biological Sciences, Monash University, Australia. (Esler, Foxcroft)

Assessing silver carp distribution using e-DNA in Kruger National Park. Collaborators: Dr Steven Crookes, Great Lakes Institute for Environmental Research, University of Windsor and Biodiversity Institute of Ontario, University of Guelph, Canada and Prof. Nicholas Mandrak, Department of Biological Sciences, University of Toronto Scarborough, Canada. (Foxcroft)

Biochemical and functional profile of secondary metabolites of invasive alien plants. Collaborator: Prof. Ilya Raskin, Global Institute for BioExploration, Rutgers University, USA. (Foxcroft)

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 University of Port Elizabeth, PO Box 1600, Port Elizabeth 6000, South Africa (Esler)

Biology of Mediterranean-Type Ecosystems. Collaborator: Dr Brandon Pratt, Department of Biology, California State University Bakersfield, Bakersfield, California (Esler)

Centrarchid fisheries and impacts. Collaborators Prof. Michael Allen, University of Florida; Nicholas Mandrak, University of Toronto Scarborough and Prof. Jean Vitule Universidade Federal do Paraná, Brazil (Weyl)

Comparative aspects of fish Invasions in Brazil and South Africa. Collaborators: Prof. Jean Vitule, Universidade Federal do Parana, Brazil (Weyl)

Ecologically-based pest rodent management. Collaborators: Prof. Steve Belmain, Natural Resources Institute, University of Greenwich; other collaborators from University of Swaziland, University of Namibia, Association Vahatra in Madagascar, and Sekoine University of Agriculture in Tanzania (Taylor)

Ecopath modelling of rocky shores. Collaborator: Marta Coll, Spanish National Research Council, Institute of Marine Science, Spain (Robinson)

Environmental Impact Classification of Alien Taxa (EICAT). Collaborators: Tim Blackburn, University College London, London; Tom Evans, University College London, London; Jonathan Jeschke, Ecosystem Research, IGB Leibniz-Institut of Freshwater Ecology and Inland Fisheries, Berlin, Germany.; Sven Bacher, Department of Biology, Unit Ecology and Evolution, University of Fribourg, Switzerland; Piero Genovesi, ISPRA (Institute for Environmental Protection and Research), Italy; John Wilson, SANBI and Centre for Invasion Biology, Stellenbosch University (Kumschick, Richardson, Wilson)

Functional responses in aquatic ecosystems: Prof. Jaimie Dick, Queens University UK; Dr Ryan Wassermann SAIAB; Dr Mhairi Alexander, University of West Scotland; Dr Tatenda Dalu and Prof. William Froneman, Rhodes University (Weyl)

Generic Impact Scoring System. Collaborators: Sven Bacher, Department of Biology, Unit Ecology and Evolution, University of Fribourg, Switzerland; Tom Evans, University College London, London; Zuzana Marková, Institute of Botany, Academy of Sciences of the Czech Republic;

Jan Pergl, Institute of Botany, Academy of Sciences of the Czech Republic; Petr Pyšek, Institute of Botany, Academy of Sciences of the Czech Republic and Department of Ecology, Faculty of Science, Charles University in Prague, Czech Republic; Montserrat Vilà, Estación Biológica de Doñana (EBD-CSIC), Sevilla, Spain; and Wolfgang Nentwig, Institute of Ecology and Evolution, University of Bern, Switzerland (Kumschick, Richardson, Wilson)

Global change effects on small mammals and bat ecosystem services (biological control of invasive crop pests). Collaborators: Prof. Teja Tscharntke and Dr Ingo Grass, University of Göttingen (Taylor)

Impacts of alien birds. Collaborators: Tim Blackburn, University College London, London; and Tom Evans, University College London, London (Kumschick)

Inferring demographic processes from invasive species distributions in New Zealand. Collaborator: Prof. Ramiro Bustamante, University of Santiago, Chile. (Le Roux)

Insect low temperature biology. Prof. Vlad Kostal and Dr Petr Simek, Institute of Entomology, Czech Academy of Sciences, Czech Republic; and Prof. Jesper Sorensen, Dept of BioScience, Aarhus University, Aarhus, Denmark (Terblanche)

Insect niche shifts. Collaborator: Dr Belinda Gallardo, IPE-CSIC Pyrenean Institute of Ecology, Zaragoza, Spain. (Terblanche)

Metabolic fuel use. Collaborators: Prof. Marshall McCue, St Mary's University, San Antonio, Texas, USA (Clusella-Trullas, Terblanche)

National Alien Cactus Working Group. Collaborators: various (SANBI, PPRI, DEA, DAFF, Rhodes University, CapeNature) (Richardson, Wilson)

National Alien Grass Working Group (incl. bamboos). Collaborators: Philip Ivey, Ingrid Nänni, Sebataolo Rahlao, Lyn Fish, SANBI; David Le Maitre, CSIR; Kim Canavan, Rhodes; Vernon Visser, UCT; Susan Canavan, C·I·B (Kumschick, Richardson, Wilson)

Novel detection methods for early invaders and rare species: Collaborators: Prof. Nicholas Mandrak, University of Toronto Scarborough, Canada; Prof. Hugh MacIsaac, University of Windsor, Canada; Prof. Anthony Ricciardi, McGill University, Canada and Dr Steven Crookes, University of Windsor, Canada (Weyl)

Oxford University Press Book project: Biology of Mediterranean-Type Ecosystems Collaborator: Dr Anna Jacobsen, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311-1099 (Esler)

Parakeet monitoring. Collaborators: Prof. Craig Symes, APES, University of Witwatersrand, South Africa (Downs)

Parasites of *Harmonia axyridis*. Collaborator: Danny Healwaters, Harvard University, USA (Clusella-Trullas)

Patterns and spread of plant invasions. Collaborator: Prof. Petr Pyšek, Institute of Botany, The Czech Academy of Sciences, Průhonice, and Charles University, Prague. (Foxcroft, Richardson)

Phenotypic plasticity. Collaborators: Prof. Ary Hoffmann, University of Melbourne, Australia; Prof. Carla Sgro, Monash University, Australia (Terblanche)

Pre-Border Risk Assessment: Collaborator: Reuben Keller, Institute of Environmental Sustainability, Loyola University Chicago, USA (Kumschick)

Predicting the impacts of climate change on terrestrial insects across Africa. Collaborators: Dr Brent Sinclair, Department of Biology, University of Western Ontario, Canada; and Dr Mhairi McFarlane, The Nature Conservancy of Canada, Canada (Terblanche)

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: Dr Armanda Bastos, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa; Dr Volker Schwan, Department of Veterinary Tropical Diseases, University of Pretoria (Chimimba)

Regime shifts concepts and theories, modelling: Collaborators Prof. Reinette Biggs, Centre for Complex Systems in Transition, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa, and Stockholm Resilience Centre, Stockholm University, Sweden (Gaertner)

Restoration of Natural Capital. Collaborator: Prof. Sue Milton, RENU KAROO, Prince Albert; and Dr David Le Maitre, CSIR, Stellenbosch (Esler)

Restoration of Natural Capital. Collaborator: Prof. James Blignaut, ASSET Research, Jabenzi, Beatus (Esler)

Risk assessment of tarantula species in the pet trade in South Africa. Collaborator: Prof. AS Dippenaar-Schoeman (Foord, Robertson)

River Rehabilitation: Dean Impson, CapeNature; Dr Martine Jordaan, CapeNature; Jeanne Gouws, CapeNature; Dr Darragh Woodford, Wits University; and Dr Brian Finlayson, California Fish and Game (van Wilgen, Weyl)

Sani Pass ant diversity project. Collaborator: Dr Kate Parr, School of Environmental Sciences, University of Liverpool, Liverpool (Robertson)

Scientometrics of Working for Water literature. Collaborator: Dr Nadia Sitas, CSIR, Stellenbosch (Esler)

Socio-economic impact classification: Collaborators: Sven Bacher, Department of Biology, Unit Ecology and Evolution, University of Fribourg, Switzerland ; Petr Pyšek, Institute of Botany, Academy of Sciences of the Czech Republic and Department of Ecology, Faculty of Science, Charles University in Prague, Czech Republic; Montserrat Vilà, Estación Biológica de Doñana (EBD-CSIC), Sevilla, Spain; Wolfgang Nentwig, Institute of Ecology and Evolution, University of Bern, Switzerland; Piero Genovesi, ISPRA (Institute for Environmental Protection and Research), Italy; Tim Blackburn, University College London, London; Marc Kenis, CABI, Delemont, Switzerland; Wolfgang Rabitsch, Umweltbundesamt, Vienna, Austria; Jonathan Jeschke, Freie Universitaet Berlin, Germany; : Franz Essl, Umweltbundesamt, Vienna, Austria; Jaakko Heikkilä, Natural Resources Institute Finland (Luke), Helsinki, Finland; Glyn Jones, The Food and Environment Research Agency, UK; Reuben Keller, Institute of Environmental Sustainability, Loyola University Chicago, USA; Christoph Kueffer, Institute of Integrative Biology, ETH Zurich, Switzerland; Angeliki F. Martinou, Joint Services Health Unit, Cyprus; Jan Pergl, The Czech Academy of Sciences, Průhonice, Czech Republic; Helen E. Roy, Centre for Ecology and Hydrology, UK; Wolf-Christian Saul, Freie Universitaet Berlin, Germany; Riccardo Scalera, IUCN/SSC Invasive Species Specialist Group, Italy (Kumschick, Richardson, Wilson)

Soil microbiome impacts of Australian acacias. Collaborator: Prof. Phil Hulme, BioProtection Research Centre, Lincoln University, Lincoln, New Zealand. (Le Roux)

Traits of marine invasive crabs. Collaborator: Dr Vernon Visser, Department of Statistical Sciences, University of Cape Town, South Africa (Robinson)

Urban invasions working group: Collaborators: Errol Douwes, eThekwini Municipality, Durban; and Ulrike Irlich, Green Jobs Unit, City of Cape Town, Environmental Resource Management Department, Cape Town (Gaertner, Hui, Richardson, Rouget, Wilson)

Xenopus genetics. Collaborator: Prof. Ben Evans, Biology Department, McMaster University (Measey).

A. 4. Information brokerage

A. 4.1 Popular articles and talks

Articles

Measey, J., Backeljau, T., Herrel, A., Rebelo, R. & Rödder, D. (2016) Unbekannte Eindringlinge: der afrikanische Krallenfrosch in Europa. Terraria58: 58-63.

Talks

Downs, C.T. 2016. The importance of curiosity in Biology. Eston-Thonville Garden Club, Manderston.

Downs, C.T. 2016. The importance of curiosity in Biology. St Charles, Pietermaritzburg.
Downs, C.T. 2016. Urban ecosystems- novel or not? An overview of urban biodiversity research. School of Life Sciences, Annual Research Day.
Ebrahim, Z. 2016. Twelve rivers of Table Mountain, freshwater monitoring. TMNP Research committee meeting. Cape Research Centre. Tokai. November 2016.
Foxcroft, L. 2016. Perceptions of the current state of Strategic Adaptive Management in South African National Parks. Presentation for the First Workshop for the Advancement of Strategic Adaptive Management, Rondevlei.
Kumschick, S. 2016. A global classification system for alien species. Seminar Series NLU, University of Basel, Switzerland. 26 September.
Kumschick, S. 2016. Classifying alien species according to their impacts. Lecture Series in Ecology and Evolution. University of Bern, Switzerland. 27 September 2016.
Kumschick, S. 2016. Towards a global classification system for alien species. Department of Statistical Sciences, University of Cape Town, South Africa: 11 April 2016.
Robinson, T.B. 2016. *Yachts and fouling.* Port Owen Yacht Club public lecture, Port Owen.
Thorp, C.J. 2016. All you need to know about amphibians. Elkanah High School Guest Lecture, Sunningdale.
Weyl, O.L.F. 2016. Determining priorities, cutting losses and managing conflicts associated with aquatic invasions: a South African perspective.
Weyl, O.L.F. 2016. Fish and Fisheries in Lake Malawi. Gießener Geograpischen Gesellschaft, Justus Liebling Universitaet, Giessen, Germany. June 2016.
Weyl, O.L.F. 2016. Fish, fishing & conservation in South Africa. Western Kentucky University, USA. April 2016.
Weyl, O.L.F. 2016. Freshwater fish conservation in South Africa. Western Kentucky University, USA. April 2016.
Weyl, O.L.F. 2016. Southern African perspectives fisheries and fish migrations, threats and opportunities. WRC, World Fisheries Day and Workshop on the South African Swimway Programme. Pretoria. November 2016.
Weyl, O.L.F. 2016. Using multiple Information sources to make sense of fish invasions. Western Kentucky University, USA. April 2016.

A. 4.2 Media interactions

Newspaper articles

Anonymous. 2016. Scifest awards ceremony. Grocott's Mail, 15 April 2016.
Bega, S. 2016. Invasive species a threat to Garden Route's future. Saturday Star, 2 July 2016.
Bega, S. 2016. Pine guzzlers great risk to Cape's water. Saturday Weekend Argus, 2 July 2016.
Brits, E. 2016. Dennebome slurp Tuinroete se water op. Die Burger, 1 Julie 2016.
De Klerk, R. 2016 Wolf in sheep's clothing invading shore line. SANParks Times, 11 February 2016
Hyman, A. 2016. Cannibals on chopping block. The Times, 4 February 2016.
Van Zyl, E. 2016. Karoo's junior rangers get ant-wise with Iimbovane. SANParks Times. 12 May 2016.

Articles published by Stellenbosch University

None in 2016.

Electronic sources

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Measey, J. 2016. Interview on CapeTalk about Western Leopard Toads and herbicides, September 2016.

Shackleton, R. 2016. Interview on Radio Today, Sappi Nature Journal, on alien invasive plants in South Africa, 2 July 2016.

Van Wilgen, B. 2016. Interview on Cape Talk on the Working for Water Programme, 12 July 2016.

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A. 5. Service provision

A. 5.1 International panels and committees

IUCN Species Survival Commission- Crocodile Specialist Group: Member (Downs)

IUCN Species Survival Commission- SSC Stork, Ibis and Spoonbill Specialist Group: Member (Downs)

Pan African Ornithological Congress Scientific Panel (Downs)

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

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

Mediterranean Research managers International Cooperative: Member (Esler)

IUCN Species Survival Commission – IUCN Spider Specialist Group: Member (Foord)

IUCN Species Survival Commission- Invasive Species Specialist Group: Member (Foxcroft, Kumschick, Richardson, Wilson)

COST Action TD1209 "Alien Challenge": Management Committee Observer (Kumschick)

Environmental Impact Classification for Alien Taxa Unit: Convener (Kumschick)

IUCN Species Survival Commission – Amphibian Specialist Group – Southern Africa: Chair (Measey)

IUCN Species Survival Commission – Amphibian Specialist Group – Southern Africa: member (Rebelo/Measey)

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

IUCN Species Survival Commission Re-introduction specialist Group: Member (Somers)

IUCN Species Survival Commission Otter Specialist Group: Member and Southern African Coordinator (Somers)

IUCN Species Survival Commission Wild Pig Specialist Group: Member (Somers)

IUCN Species Survival Commission Small Carnivore Specialist Group: Member (Somers)

IUCN Species Survival Commission – Non-Volant Small Mammals Group: Member (Taylor)

Co-organiser, Symposium on insect responses to climate change, International Congress of Entomology 2016, Florida (USA) (Terblanche)

Board Member, South African National Biodiversity Institute (van Wilgen)

DEA Natural Resource Management Programmes – Research Advisory Panel (van Wilgen)

American Fisheries Society, International Fisheries Section Advisory Board member (Weyl)

IUCN Species Survival Commission (SSC), Freshwater Fish Specialist Group, Regional Chair Southern Africa (Weyl)

Future Earth bioDISCOVERY Core Project, Scientific Committee member. (Weyl)

Global Biodiversity Information Forum Task Team on Data Fitness for Use on Alien and Invasive Species (Wilson)

International Plant Sentinel Network: International Advisory Group Member (Wilson)

A. 5.2 National panels and committees

Adjudication panel member (Vice Chairperson): National Science and Technology Forum (NSTF) (Chimimba)

Alien Species Risk Analysis Review Panel (ASRARP): member (Kumschick)

Berg River Clearing and Rehabilitation Advisory Committee: Technical Advisor (Esler)

C.A.P.E. Invasive Alien Animal Working Group South Africa: Member (Wilson)

Endangered Wildlife Trust - Healthy Rivers Programme: Panel of Experts (Weyl)

Flower Valley Conservation Trust Sustainable Harvesting Programme Research Working Group: Member (Esler)

Fynbos Forum Committee: Member (Esler)

HERS Advisory Board: Chair (Esler)

Member: Advisory Board, Research Committee, South African National Biodiversity Institute (SANBI) (Chimimba)

Member: Board of Directors, South African National Biodiversity Institute. Member (van Wilgen)

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

Reference and Advisory Committee for the National Status Report on Biological Invasions in South Africa (Richardson)

Research Advisory Panel for the Environmental Programmes Branch of Department of Environmental Affairs: Ex-officio Member (Wilson)

SACNASP Qualifications Assessment Committee: Member (Taylor)

SAEON Fynbos Node Liaison committee: Member (Esler)

South African Data Centre for Oceanography (SADCO) – resigned mid 2016: Board member (Griffiths)

South African National Biodiversity Institute (SANBI) Alien Species Risk Analysis Review Panel (ASRATP) member (Weyl)

South African National Invasive Alien Animal Forum: Member (Wilson)

Water Research Commission Reference Group: The use of long-term, large-scale data combined with historic ecological data to support reserve implementation: Member (Esler)

Zoological Society of southern Africa – Hon. Treasurer (Downs)

A. 5.3 Editorial and refereeing activities

Editor / Editor-in-Chief

African Journal of Herpetology (Measey)

BioInvasions Records (Wilson)

Conservation Biology (van Wilgen)

Koedoe (Foxcroft)

Associate Editor

African Journal of Wildlife Research (Somers)
African Zoology (Weyl)
Aquatic Invasions (Weyl)
BioInvasions Records (Measey, Weyl)
Biological Invasions (Hui, Le Roux, Richardson, Weyl)
BMC Ecology (Hui)
Climate Change Responses (Terblanche)
Conservation Genetics (Le Roux)
Diversity and Distributions (Robertson, Wilson)
Functional Ecology (Clusella-Trullas)
Ibis (Downs)
Insect Conservation and Diversity (Hui)
Journal of Fish Biology (Weyl)
Journal of Thermal Biology (Clusella-Trullas)
Koedoe (Somers)
Mammalian Biology (Somers)
Neobiota (Foxcroft, Richardson)
PeerJ (Esler, Measey, Somers)
Salamandra (Measey)
South African Journal of Science (van Wilgen)
Urban Ecosystems (Downs)

Editorial Boards

Acta Chiropterologica (Taylor)
African Entomology (Terblanche)
African Natural History (Griffiths)
Animals (Griffiths)
AoB Plants (Richardson)
Applied Mathematics and Computational Sciences (Hui)
Austral Entomology (Terblanche)
Cambridge University Press book series: Conservation Biology (Richardson)
Cambridge University Press book series: Ecology Biodiversity and Conservation (Richardson)
Ecological Complexity (Hui)
Frontiers in Ecology and Evolution (Hui)
Frontiers in Insect Physiology (Clusella-Trullas)
Journal of Thermal Biology (Terblanche)
Koedoe (Griffiths)
Malagasy Nature (Taylor)
Mammalia (Taylor)
Ostrich (Downs)
Russian Journal of Biological Invasions (Richardson)
The Open Zoology Journal (Hui)
The Scientific World Journal (Hui)
WIRMS (Robinson)
Zookeys (Foord)

Reviewing

<u>National</u>

African Biodiversity and Conservation (Bothalia)
African Journal of Aquatic Science
African Journal of Marine Science
African Journal of Wildlife Research
African Zoology
Annals of the Ditsong Museum
Koedoe
Ostrich
South African Journal of Botany
South African Journal of Science
Transactions of the Royal Society of South Africa
Water SA

<u>International</u>

Acta Adriatica
Acta Chiropterologica
Acta Theriologica
African Journal of Ecology
African Zoology
American Naturalist
Animal Biology
Animal Conservation
Annals of Botany
AoB Plants
Applied Ecology and Environmental Research
Aquatic Invasions
Austral Ecology
BioControl
Biodiversity and Conservation
Bioinvasions Records
Biological Conservation
Biological Invasions
Biological Journal of the Linnean Society
BioScience
Biotropica
Canadian Journal of Zoology

Condor
Conservation Biology
Conservation Letters
Crustaceana
Current Zoology
Diversity and Distributions
Ecography
Ecohealth
Ecological Research
Ecology Letters
Ecosphere
Ecosystem Services
Environment & Planning C: Government and Policy
Environmental Monitoring and Assessment'
Estuarine, Coastal and Shelf Science
Fisheries Research
Florida Entomologist
Forestry Ecology and Management
Frontiers in Ecology and the Environment
Functional Ecology
Genetica
Global Change Biology
Global Ecology and Biogeography
Global Ecology and Conservation
Herpetologica
Herpetology Notes
Insect Science
Integrative and Comparative Biology
Integrative Zoology
International Journal of Biodiversity and Conservation
International Journal of Biodiversity Science, Ecosystem Services and Management
International Journal of Plant and Animal Sciences
International Journal of Science Education
Journal of Applied Ecology
Journal of Arid Environments
Journal of Biogeography
Journal of Ecology
Journal of Experimental Biology
Journal of Herpetology
Journal of Insect Physiology
Journal of Molluscan Studies
Journal of Ornithology
Journal of Vegetation Science
Journal of Zoology
Land Degradation and Development
Landscape Ecology
Limnologica
Malagasy Nature
Mammal Research
Marine Biodiversity
Marine Biology Research
Methods in Ecology and Evolution
Microscopy Research Technique
Molecular Ecology
Molecular Phylogenetics & Evolution
Mountain Research and Development
Nature Communications
Nature Ecology & Evolution
Natureza & Conservação
NeoBiota
New Phytologist
New Zealand Journal of Botany
Oecologia
Ostrich
Parasites and Vectors
Peer J
Physiological Biochemistry & Zoology
Physiology & Behaviour
Plant Ecology
PLoS ONE
Proceedings of the Royal Society B
Reviews in Fish and Fisheries
Risk Analysis
Science of the Total Environment
Scientific Reports
Southern Forests
Transactions of the Royal Society
Trends in Ecology and Evolution
Zootaxa

Grant reviews for external bodies

EarthWatch (Somers)
Estonia Research Council (Esler)
National Geographic (Downs)
National Science Foundation (Downs)
NERC (Downs)
Research Foundation Flanders (Kumschick)
Rufford Small Grants (Davies)

SANBI (Somers)

Appointment reviews and committees

Monash University, Australia: promotion to Senior Lecturer (Richardson)
Pretoria University, South Africa: Promotion to Associate Professor (Byrne)
Purdue University, USA: Promotion to Professor (Richardson)
Rhodes University, South Africa: Honorary Professorial Appointment (Weyl)
Stellenbosch University, Department Conservation Ecology and Entomology: Lecturer/Senior Lecturer Appointment (Terblanche)
University of KwaZulu-Natal: various (Downs)
University of Toronto Scarborough, Canada: Assistant Professorial Appointment (Weyl)
University of Waterloo, Canada: Professorial Appointment (Esler)

A. 5.4 Consulting and other services rendered

Consultancy products

McGeoch, M. A., Groom, Q. J., Pagad, S., Petrosyan, V., Ruiz, G. and Wilson, J. (2016) Data fitness for use in research on alien and invasive species. Copenhagen: GBIF Secretariat. http://www.gbif.org/resource/82958 (Wilson). This sets out ways in which global data can be better co-ordinated, managed and delivered to facilitate research and action on biological invasions.

A. 5.5 NRF Service Provision

NRF reviews:

Competitive Programme for Rated Researchers, project evaluation
Competitive Programme for unrated researchers, project proposal evaluation
Evaluation and rating: review of application for rating (1)
Focus Area - Conservation and Management of Ecosystems and Biodiversity: project proposal reviews
IRG - Flemish / South Africa Research Cooperation Programme review
NRF Rating reviews (4)
NRF Review Panel: Competitive Programme for Rated Researcher (CPRR), Competitive Support for Unrated Researchers (CSUR) and Research Development Grants for Rated and Unrated Researchers, 23 - 24 August 2016, NRF, in Pretoria
Thuthuka – Project Proposal Review (2)

Panel and committee service

Advisory panel: SANBI genetic monitoring panel
Competitive Programme for Rated Researchers: review panel
RTF audit panel: Mariculture project based at the University of Cape Town.

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