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DST-NRF Centre of Excellence for Invasion Biology

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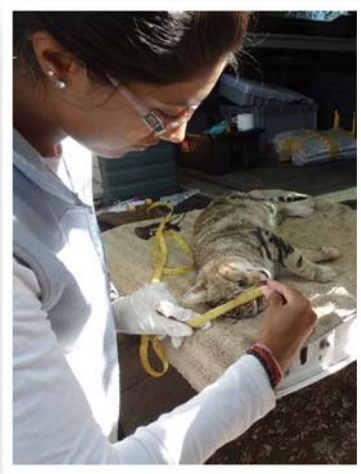
Annual Report 2015



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Published by:
DST-NRF Centre of Excellence for Invasion Biology
Faculty of Science • Stellenbosch University
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Room 2039 • 2nd Floor • Natural Sciences Bdg. • Main Campus
http://www.sun.ac.za/cib

March 2016

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Executive summary

Reporting period	:	1 January 2015 - 31 December 2015
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 our five Key Performance Areas (KPAs)

Research

The C·I·B's research addressed a wide range of disciplines, scientific approaches, issues, spatial and temporal scales, and taxa during 2015, resulting in the most productive year in our history in terms of publications. We published 178 peer-reviewed papers in 113 journals (107 ISI-accredited and 7 non-ISI), including contributions in the high-impact journals *Nature*, *Nature Communications*, *Proceedings of the National Academy of Sciences of the USA*, *Proceedings of the Royal Society B*, and *Trends in Ecology & Evolution*. Another four contributions appeared in edited books. Our publications for 2015 covered many of the most pressing issues in invasion ecology internationally and in a South African context, and the full spectrum of focus areas identified in the C·I·B's strategic plan for 2014-2019. Our research addresses fundamental issues related to the biology of invasive species, aspects of invaded ecosystems, invasion processes, and many facets of the human dimensions of invasions. The report that follows provides an idea of the research outputs for 2015. Further details of these and other publications produced during 2015 are available on the C·I·B website.

Education and Training

In 2015, the C·I·B supported 68 students and 16 post-doctoral associates. For the first time we had seven South African post-doctoral associates (44% of the total), the majority of whom were graduates of the C·I·B programmes, reflecting the success of the CoE at 'growing its own timber'. Altogether, the C·I·B hosted 21 foreign students and post-doctoral associates from African countries Madagascar, Rwanda, Uganda and Zimbabwe, and from Australia, Canada, Chile, Germany, Ireland, Italy, Portugal,

Spain the UK and the USA. Graduations in 2015 included seven honours/4th year (four black, three white), 12 Masters (seven black, five white) and 7 PhDs (three black, four white).

Among the 86 students and post-doctoral associates, 31 students and eight post-doctoral associates were fully supported (bursary and project running costs), while 18 students and one post-doctoral associate received partial support (in the form of a partial or full bursary, running costs only, or 'in kind' support, e.g. supervision by a core team member). Independent funding was sourced by 19 students and eight post-doctoral associates, from other funding institutions, private foundations, and other (non-CoE) NRF instruments. However, raising additional funds for student and post-doctoral support remains a challenge and a high priority for the Centre's management team (see Red Flags).

Networking

In 2015 the C·I·B continued and developed its interactions with its national and international partner organisations. Crucial funding partnerships with SANBI and the Natural Resources Management Programme of Dept. Environmental Affairs were backed by successful production of joint workshops, peer-reviewed publications and student graduations. The C·I·B fellowship programme went from strength to strength, with the appointment of four Visiting Fellows and one Fulbright Fellow – one each from Australia, Brazil, Canada and the USA. A local highlight was the interaction with the University of Cape Town's MPhil course in Environmental Humanities, which has already resulted in one co-supervised student and several joint publications, and promises to improve our impact on the social sciences in future.

Information Brokerage

C·I·B team members hosted several important workshops, including two international workshops on Functional responses as a tool in invasion ecology and Evolutionary dynamics of tree invasions: drivers, dimensions, and implications for management, as well as a national workshop on Conservation in the Cape Floristic Region. All these will lead to several collaborative publications and joint student supervisions with other institutes. In addition, the C·I·B co-funded the 6th International Symposium-Workshop on Frugivores & Seed Dispersal in KwaZulu-Natal.

The Iimbovane outreach programme deepened its involvement in the target schools in the Western Cape, and in monitoring the outcomes of its interactions with learners. In this regards we saw several 'alumni' of the programme embark on undergraduate degrees in the life sciences.

Generally, the C·I·B's activities resulted in a host of media interactions, from print media to radio and television. Our presence in social media expanded with very active website, Facebook and Twitter pages.

Service Provision

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 the Department of Environmental Affairs (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.

C·I·B-affiliated researchers hold prominent positions as Editors-in-Chief, Editors, Associate Editors, and serve on Editorial Advisory Boards of many top journals. C·I·B Director Dave Richardson stepped down at the end of 2015 as Editor-in-Chief of the journal *Diversity and Distributions* after 19 years at the helm of that publication. Our team members acted as editors of several important journal special issues during 2015. The expertise of our core team members is often sought to evaluate funding applications and staff appointments from many parts of the world.

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

Invasive species heavily affect women, who bear the most responsibility for agriculture, water provision and household management. Public engagement and application of invasion science is crucial to bring research results into policy and practice, and this forms the focus of greater effort in the current phase of the Centre's development. In terms of the other KPAs, women represent 31% of the core team (8 out of 26), but are much better represented among the C·I·B staff (83%; 15 out of 18), post-doctoral associates (56%; 9 out of 16) and students (52%; 36 out of 68). The Iimbovane project is staffed entirely by women, providing a powerful role model and informal career path guidance for aspiring scientists. Iimbovane is increasingly being drawn into hosting learners who wish

to do vacation work in the Iimbovane labs, and interestingly, it is almost invariably young women who volunteer in this way.

Red Flags

The C·I·B has another four years of assured funding from the Department of Science and Technology, through the NRF. Although we generate substantial funds to support our operating costs from outside sources, core funding from DST is crucial for maintaining the infrastructure of the C·I·B and supporting the current model which is providing excellent service to our network of team members in higher education institutions and partner organizations. In 2015, discussions were held with several partner organizations about options for restructuring the C·I·B. This is an issue that will need to receive increasing attention in the near future to allay the concerns of staff regarding job security and to prevent the C·I·B from losing momentum. Currently we are arguably the world's most productive research and training unit in the field of invasion science.

General Comments

2015 was a very successful year for the C·I·B. Our papers continue to appear in all the top-rated ecology journals and received many citations, and much attention in the media. The C·I·B continued to make substantial contributions to policy relating to biological invasions and associated issues in South Africa and internationally. Various measures clearly show that the Centre is widely acknowledged as a global centre of excellence in this field. New partnerships continue to be sought to ensure coverage of all geographic and thematic areas in South Africa. Our partnerships with the Natural Resources Management Programmes, the South African National Biodiversity Institute, the South African Institute for Aquatic Biodiversity and the City of Cape Town were especially productive during 2015. Our international Research Associates were very productive during the year. Besides boosting the C·I·B's output of publications these collaborations build crucial partnerships that improve the global reach and reputation of the C·I·B and provide exciting opportunities for C·I·B-affiliated personnel (core team members, research associates, students and post-doctoral associates) to work with global leaders in the field. The C·I·B Fellowship initiative is now firmly in place and is attracting top international researchers to work with core team members.

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 a 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 précis of the wide range of disciplines, taxa, spatial and temporal scales, and scientific approaches in the C·I·B's research during 2015 (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.

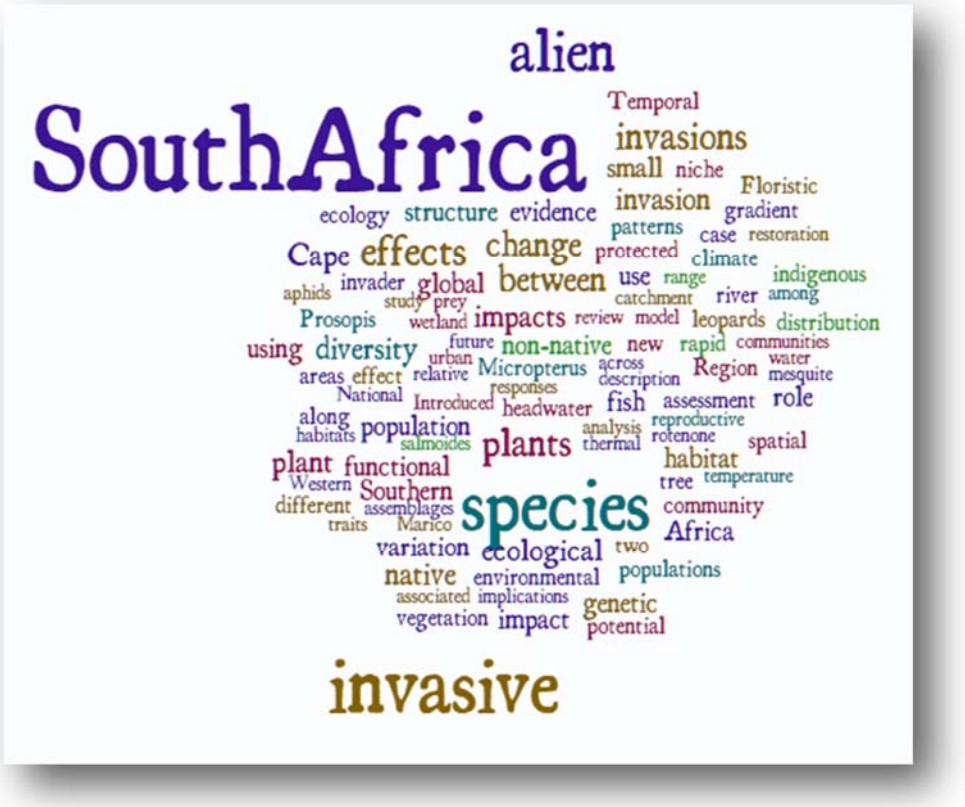


Figure 1. Word cloud reflecting the titles of C·I·B publications in 2015

1.2.1 Long-term collaborative research

Long-term change in insect 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).

Beta diversity of montane ants

A recent study involving several current and recent C·I·B affiliates explored how the composition of ant groupings changes across environmental gradients. The paper made use of data from the Sani Pass transect (Table 1) (Bishop *et al.* 2015; *J. Biogeogr.* 42: 1776–1786).

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.

The study used several new methods to assess how the ant communities changed in response to elevation (Figure 2). Firstly, changes in both the taxonomic and functional structure of the ant communities were analysed. The taxonomic part of the analysis looked at how species identities changed along the gradient. The functional aspect used morphological data to describe the ecology of the 92 different ant species. This functional description of the ant fauna recognizes that some species are similar to each other than others. For example, specialist predatory species are more ecologically similar to each other than to generalist scavenging species.

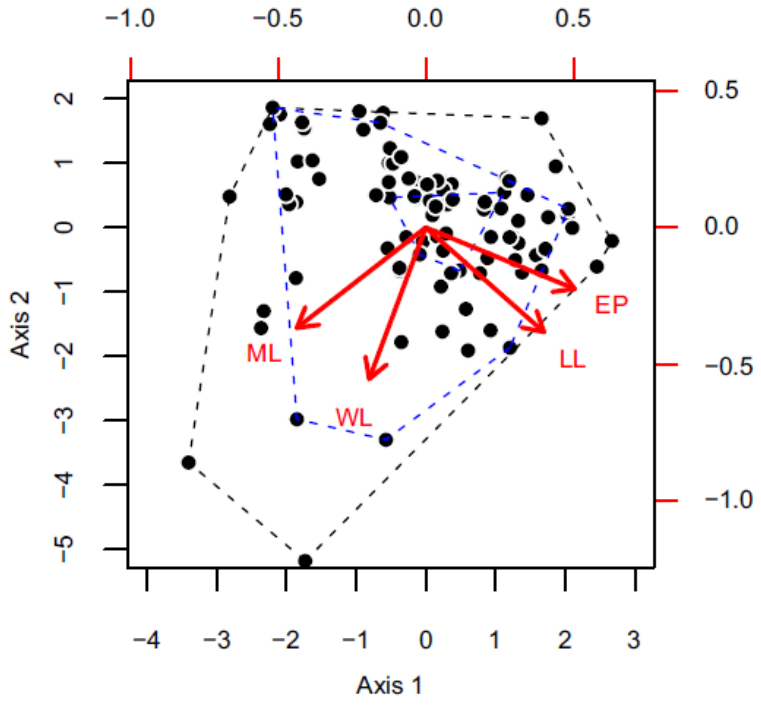


Figure 2. Biplot displaying the structure of the morphological space on the first two principal coordinate axes occupied by the ant fauna of the Sani Pass. From: Bishop et al. 2015; *J. Biogeogr*. 42: 1776–1786

Secondly, changes were ascribed to either turnover or nestedness. Turnover occurs when species (or functional types) are replaced by new ones at different parts of the gradient. Nestedness describes a pattern of species loss whereby some sites are simply "nested subsets" of those with more species.

"We found that different species occupied different elevations in a turnover pattern," said lead author Tom Bishop. *"As you climb the mountain, however, these new species tend to occupy a smaller and smaller subset of the functional types available. This is a pattern of functional nestedness. These results allow us a greater understanding into the factors that may be shaping ant ecology and biology in harsh, mountain environments."*

Monitoring the rate of spread of alien plant invasions and evaluating outcomes of management actions in the Cape Town metropole

Metropolitan areas such as the City of Cape Town (COCT) are particularly vulnerable to the introduction of invasive alien species. As one of the hottest 'hot-spots' of biodiversity, the Cape Peninsula has the highest density and number of threatened plants of any metropolitan area in the world. Alien plant invasions have been identified as being one of the biggest threats to native biodiversity and ecosystem services. Invasive plants are also regarded as a serious fire hazard in Cape Town.

The City of Cape Town's Green Jobs Unit (which is part of the Biodiversity Management Branch) is responsible for controlling invasions and restoring functional native ecosystems in Nature Reserves, Critical Biodiversity Areas and Ecological Support Areas. A major challenge for the Branch is that funding for alien clearing operations and restoration is difficult to obtain. Management actions therefore have to be carefully justified, and monitored to identify the most effective solutions and demonstrate levels of success.

One of the main objectives of the Green Jobs Unit is to monitor the spread of selected invasive plant species in relation to control efforts. The C·I·B hosts a researcher, Dr Mirijam Gaertner, who is responsible for leading the monitoring operations of the City, while post-graduate students and technical staff of the Centre assist with monitoring. Mirijam Gaertner and her team have designed a monitoring framework to answer the main important question of whether the problem of invasions in the City of Cape Town is getting worse, is stabilising, or is getting better.

In a first step the team has developed the monitoring protocol and evaluated it against previous monitoring efforts, an important task if the new long-term monitoring programme is to make optimal use of existing data and knowledge.

In a second step monitoring plots where randomly established on aerial photographs in the BIONET lowland areas within the COCT using Arc View GIS (Figure 3). Monitoring plots were used to make estimates of invasive tree cover for the following sub-groups: (1) Protected-treated areas; (2) Unprotected-treated areas; (3) Protected-untreated areas; (4) Unprotected-untreated areas. Estimated were made for 2002 and 2013 to establish how invasive tree cover changes over time.

So far 400 plots have been established and tree cover has been estimated for 2002 and 2013 respectively in treated unprotected and protected areas. In a next step plots will be established in untreated unprotected and protected areas.

In the process of estimating tree cover in the low land areas it turned out to be very difficult to distinguish between invasive *Acacia* species and native fynbos species. We therefore decided to ground-truth these areas visiting reserve and area managers.
Once the dataset is finalised the results will be processed and presented to the City of Cape Towns' Green Jobs Unit.

The C·I·B has committed to host the monitoring project for five years (until 2019).The monitoring system will be passed on to CoCT by the end of 2019 in the form of a protocol and monitoring tool for monitoring spread of invasive species and measuring success of clearing operations actions.

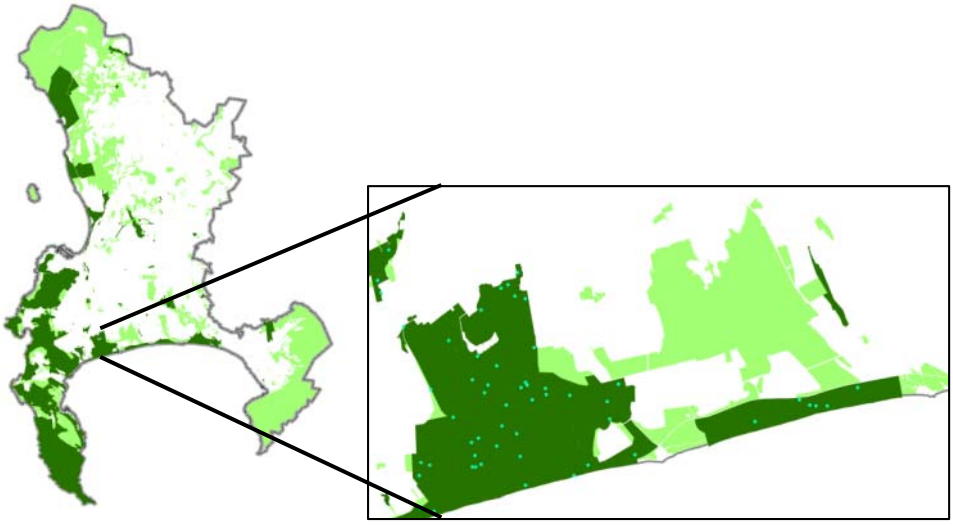


Figure 3. All green (dark and light) are the BIONET areas within the City of Cape Town boundary. The dark green areas are protected areas and parks. The inset map shows some of the randomly selected plots that will be used to make an estimate of invasive tree cover for lowland areas

1.2.2 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.

No time to waste in dealing with a biodiversity debt crisis

Recently there have been a series of debt crises in economies around the world, from Greece to Argentina to the U.S.A. Unfortunately we also have a global biodiversity debt crisis. These debt crises

share an important feature - managers need to respond to the emergency. Natural resource managers must deal with wild-fires burning out of control, or a disease outbreak threatening bee populations, or air pollution levels so high that they endanger a high-profile athletics event. The political pressure to act is often intense. However, these are examples of events where the underlying causes are far removed from the current crisis. The wild-fire might have been caused by the introduction of invasive trees centuries ago. The disease affecting bees arose from events decades ago in a different country. The air pollution might be the result of desertification kilometres away. This separation between causes and consequences is a result of a series of cumulative time-lags.

The need to understand cumulative biodiversity lags in conservation was recently highlighted in two papers by C·I·B Associate Franz Essl and colleagues at the C·I·B. Essl and colleagues found that current patterns can be poor indicators of the underlying processes. Extinction debt, invasion debt, and immigration debt are all cases where the environmental processes have been enacted (i.e. habitat destruction, introductions of alien organisms, and climate change respectively), but where the full impacts will only be known in the future (Fig 4).

How the effects of a change in environmental forcing are transmitted along a series of cause-effect relationship can take a number of forms. For example, if stones are thrown into a pond, there will be a series of ripples that interact and interfere with each other, but in a few minutes the pond level will return to its previous state (the relaxation time). In contrast, a butterfly flapping its wings in a tropical forest can (at least in theory through a series of amplified intermediary links) cause a thunderstorm on the other side of the world sometime in the future (the reaction time). In the case of the butterfly, the whole system can be permanently changed. The vast majority of cases fall somewhere in between. A key argument made by Essl *et al.* (2015; *Trends Ecol. Evol*. 30: 375–378.) is that such sequentially lagged response are not fully appreciated in (socio-) ecological research.

A good example of delayed biodiversity responses was presented in a linked paper (Essl *et al.* 2015; *Diversity Distrib*. 21: 534–547). As nitrogen deposition continues over time, a threshold can be reached beyond which the soil nitrogen content starts increasing rapidly. This causes a cascade of delayed effects on the biotic components — plants show a physiological response to the changes in soil chemistry, the change in plant tissue chemistry and plant species composition affects the herbivores, and the herbivores affect higher trophic levels. Therefore there can be time-lags between each subsequent component losing its resilience, the Damage Delay Time (DDT); and delays between the event stopping and system recovery, the Recovery Delay Time (RDT). Some of the underlying mechanisms are shown in Figure 4.

Essl and colleagues came up with five areas that need urgent attention:

- Incorporate lagged biodiversity responses into management planning;
- Include lags in long-term biodiversity projections;
- Investigate the interactions between mechanisms and how effects might cascade;
- Research thresholds and tipping points, to identify early warning-signals;
- Make explicit the role of shifting baselines in assessing environmental changes.

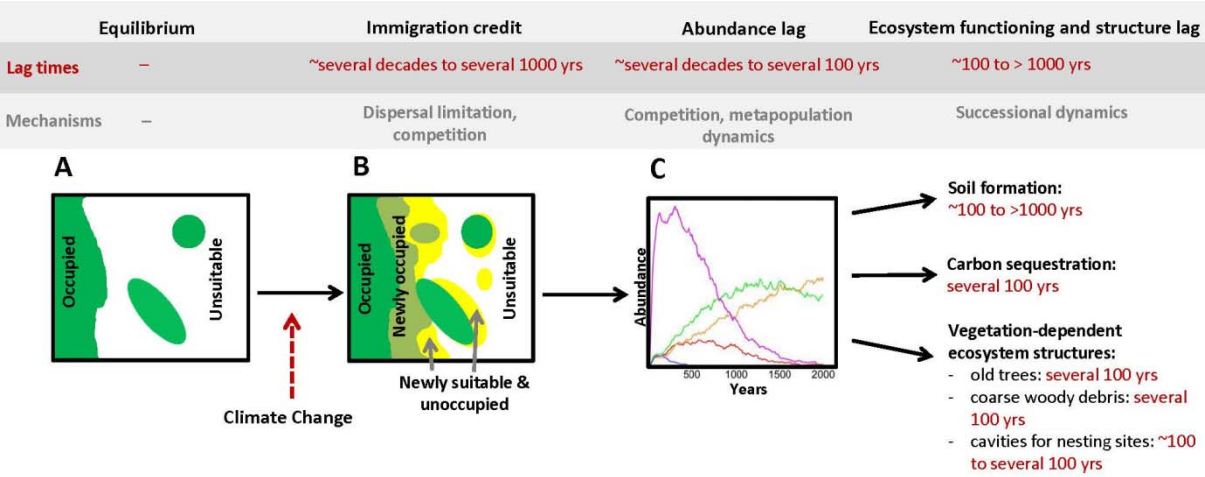


Figure 4. Examples of lagged biodiversity responses due to changing pressures. For details, see Essl *et al*. (2015) *Diversity Distrib*. 21: 534–547

Behaviour of species informs conservation strategies

Have you ever wondered why species are organized in such a way that species in one group interact more with each other, than with species in other groups? Ecologists name this form of self-organization "compartmentalization". In trying to understand how this organization happens, ecologists have noticed that consumer species are constantly selecting and adjusting their selection of resources (species) to exploit (Figure 5). They select highly profitable resources rather than consuming all available resources.

Previously, it was believed that life histories and evolutionary processes determine the groupings/compartments in ecosystems. However, a paper by C·I·B PhD student Savannah Nuwagaba showed that this behaviour of selecting and adapting (selective/adaptive behaviour mechanisms), which occurs at time-scales faster than normal ecological time-scales, could be responsible for such compartmentalisation. Savannah's study showed that adaptive behaviour can explain the level of compartmentalisation in 61 real predator-prey ecological communities (Nuwagaba *et al.* 2015; *Proc. Royal Soc. B*. 282: 2015320).

"*This behaviour allows the abundance of species to fluctuate without necessarily leading to extinction of some species*." explains Savannah. She adds "*that ignoring species' adaptive behaviour can lead to either under or overestimating expectations*. *We should carefully observe species behavioural processes as they may have important implication for conservation strategies*."

Figure 5. Herbivory, parasitism and predation are three antagonistic interactions common in nature. Images from Corbisimages and Abretelibro

Why do some frogs eat other frogs?

Normally, frogs eat small invertebrates that easily fit into their mouths, but studies of stomach contents have shown that they sometimes eat eggs, tadpoles and even adults of other frogs. What are the conditions under which frogs eat other frogs?

This was the starting place for a study led by C·I·B researchers John Measey, Giovanni Vimercati, André de Villiers, Mohlamatsane Mokhatla, Sarah Davies and Shelley Edwards. They reviewed 323 papers on frog diet, extracting variables that might help explain why frogs sometimes eat frogs (Measey *et al.* 2015; *PeerJ* 3:e1204). Each species was scored for a number of traits which included their size, whether or not the report was of an invasive population, whether or not cannibalism was reported, the habitat type, as well as the number of species that are thought to occur at the study site. Over a fifth of these records reported predation on frogs (anurophagy), and there were some superfamilies that were particularly biased in this behaviour (Figure 6).

Invasive frogs are claimed to have a negative impact on native amphibians through a number of mechanisms, but the significance of predation has rarely been quantified. The study showed that invasive frogs have a higher proportion of anurans in their diet gives substance to the claim that they are detrimental to local species. Surprisingly, invasiveness was included in the best model despite the small number of studies of the diets of invasive anurans that were available. The researchers found that large invasive frogs that live in forests with high anuran diversity are most likely to have a higher proportion of anurans in their diet.

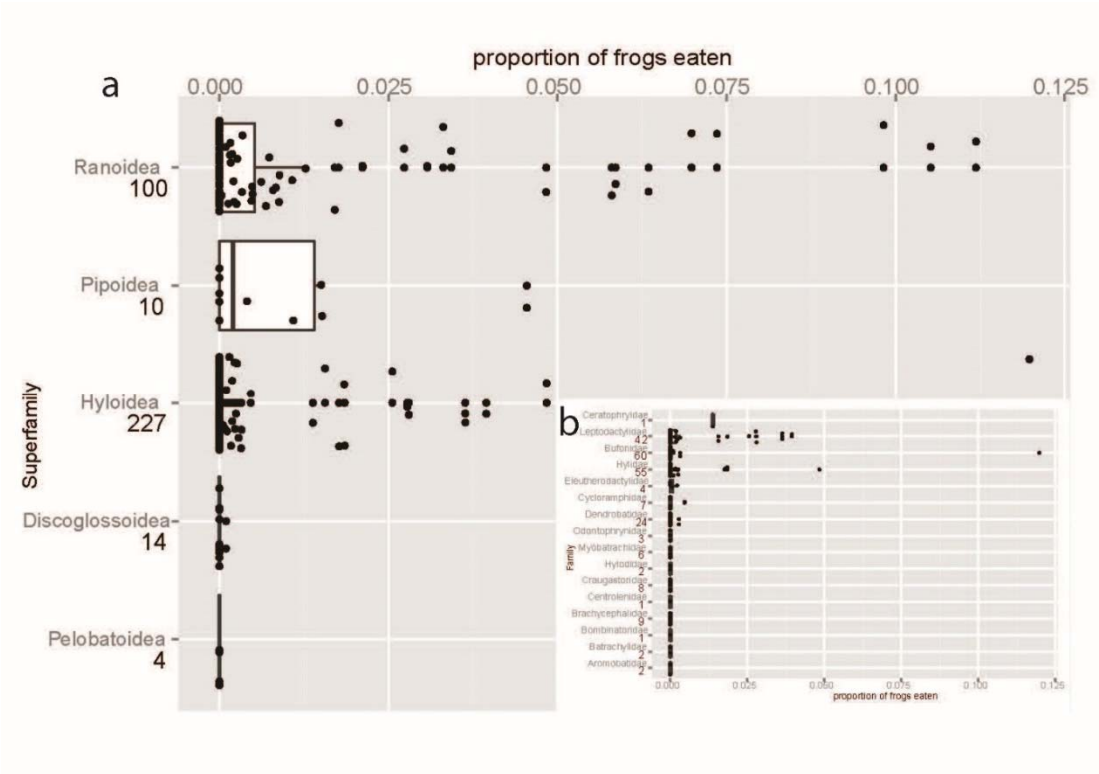


Figure 6. Taxonomic bias in anurophagy across superfamilies (From Measey *et al.* 2015; *PeerJ* 3:e1204)

"It is particularly interesting that we found invasiveness to be a significant determinant of anurophagy" said John Measey. "This will help managers who are often unaware of the effects of invasive frogs."

Skyscrapers and bungalows: the alien species real estate market on Marcus Island

A study by C·I·B PhD student, Saachi Sadchatheeswaran, examined the different number of species (species richness) and invertebrates on the rocky shores of Marcus Island after the arrival of alien species that were also ecosystem engineers. Saachi and colleagues surveyed the rocky shores in 1980, 2001 and 2012, and recorded over that period invasion by three alien species - the Mediterranean mussel (*Mytilus galloprovincialis*), the North American Pacific barnacle (*Balanus glandula*) and a tiny mussel from South America, the Bisexual mussel (*Semimytilus algosus*).

To examine the alien species' influence on the habitable volume (complexity), Saachi used a 3D graphics programme to recreate the samples collected in 1980, 2001 and 2012 (Figure 7). She found that in 1980, the habitat complexity increased with increasing proximity to the water. In 2001, the Mediterranean mussel dominated five of the six visible intertidal zones and complexity equalised across the invaded area. Then in 2012, when the Pacific barnacle and Bisexual mussel were first recorded on Marcus Island, complexity returned to 1980 levels (Sadchatheeswaran *et al.* 2015; *Biol. Invasions* 17: 1799-1816.).

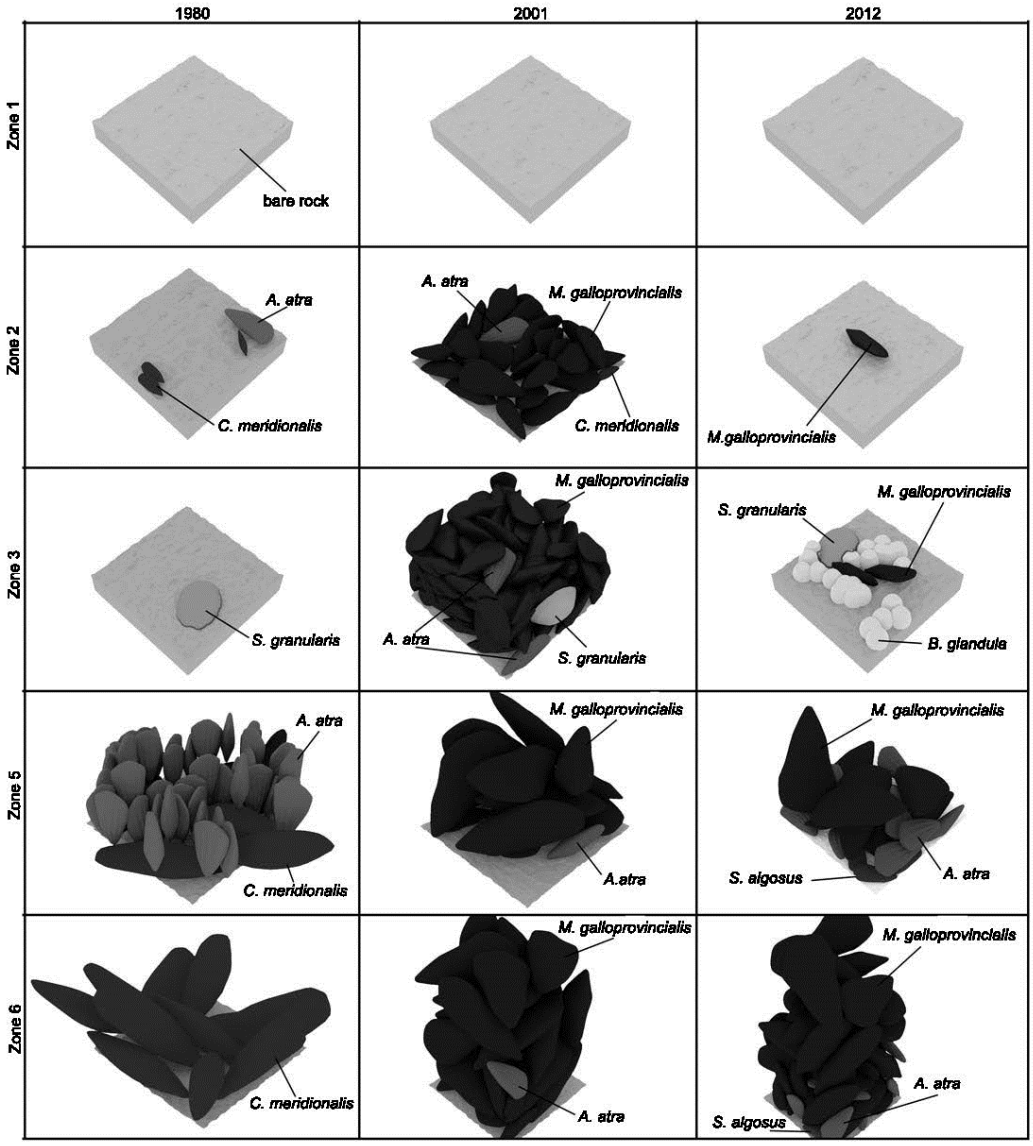


Figure 7. Three-dimensional models of rocky shore zones on Marcus Island, depicting dominant space-occupying species on five 5 cm^2 quadrats (native species: *Choromytilus meridionalis*, *Aulacomya atra*, *Scutellastra granularis*; invasive alien species: *Mytilus galloprovincialis*, *Balanus glandula*, and *Semimytilus algosus*) as sampled in 1980, 2001 and 2012. Models were generated in Blender 2.64. From: Sadchatheeswaran *et al.* 2015; *Biol. Invasions* 17: 1799-1816

"*The samples covered with the Mediterranean mussel bore a striking resemblance to skyscrapers, while the samples covered with the acorn barnacle looked like a neighbourhood of bungalows,"* says Saachi. She explains further "*Skyscrapers provide lots of living space in a small area because of vertical living; therefore more species and individuals can be accommodated. In comparison, a spread of bungalows in the same size area provides very little living space*."

Using the skyscraper-bungalow analogy, Saachi made predictions on the changes to species richness and abundance of invertebrates, and found that 18 of 20 predictions were correct. Wherever the

habitable volume (complexity) increased, decreased or stayed the same, so too did the number of species and individuals. While habitat complexity was able to predict changes to the species richness and individuals in each zone, the community structure (the actual species that make up each zone) was probably affected by a combination of habitat complexity and tidal height.

Investigating ecological effects of polyploidization in a cosmopolitan grass genus

Polyploidization, the process whereby an organism receives two whole copies of its parents' genomes (instead of half of each parents' genome), is very common among plants and is thought to be an important mechanism for creating new species (polyploids). Arguably the most important change brought about by polyploidization from an ecological perspective is an increase in genetic diversity, but other changes also occur during the process. These changes are predicted to have physiological and ultimately ecological effects on the new species. Polyploids are predicted to live in a greater range of environments, more extreme environments, and in environments different to that of their parental species.

Using the globally cosmopolitan (found across all or most of the world in appropriate habitat) grass genus *Phalaris*, C·I·B postdoc, Vernon Visser, and Jane Molofsky (University of Vermont; Jane spent part of her sabbatical leave in 2013 at the C·I·B) tested whether some of the predicted ecological effects of polyploidization held true. This genus includes reed canary grass (*P. arundinacea*), a major invader in North American wetlands and the cereal used for birdseed, canary grass (*P. canariensis*) (Visser & Molofsky 2015; *Am. J. Bot*. 102: 36 – 49).

Evidently, these predicted effects of polyploidization might be important for helping alien species to establish and eventually become invasive in their alien ranges. Previous research has already shown a strong correlation between polyploidy and invasiveness. This study therefore provides useful insight for both ecologists and invasion biologists.

Despite investigating the highest number of environmental variables of any study to date, this study found very little support for any of the predicted effects of polyploidization (Figure 8). The authors suggested that a number of factors other than polyploidization are likely playing equally important roles in shaping the ecologies of polyploid species. For example, in the case of *Phalaris*, the group originated in dry Mediterranean climates, but some polyploid species have gradually moved into wetter habitats such as wetlands and riparian areas. This is counter to the prediction that they should inhabit more stressful habitats. This suggests that understanding the ancestry and evolution of a species is just as important as knowing whether a species is polyploid or not.

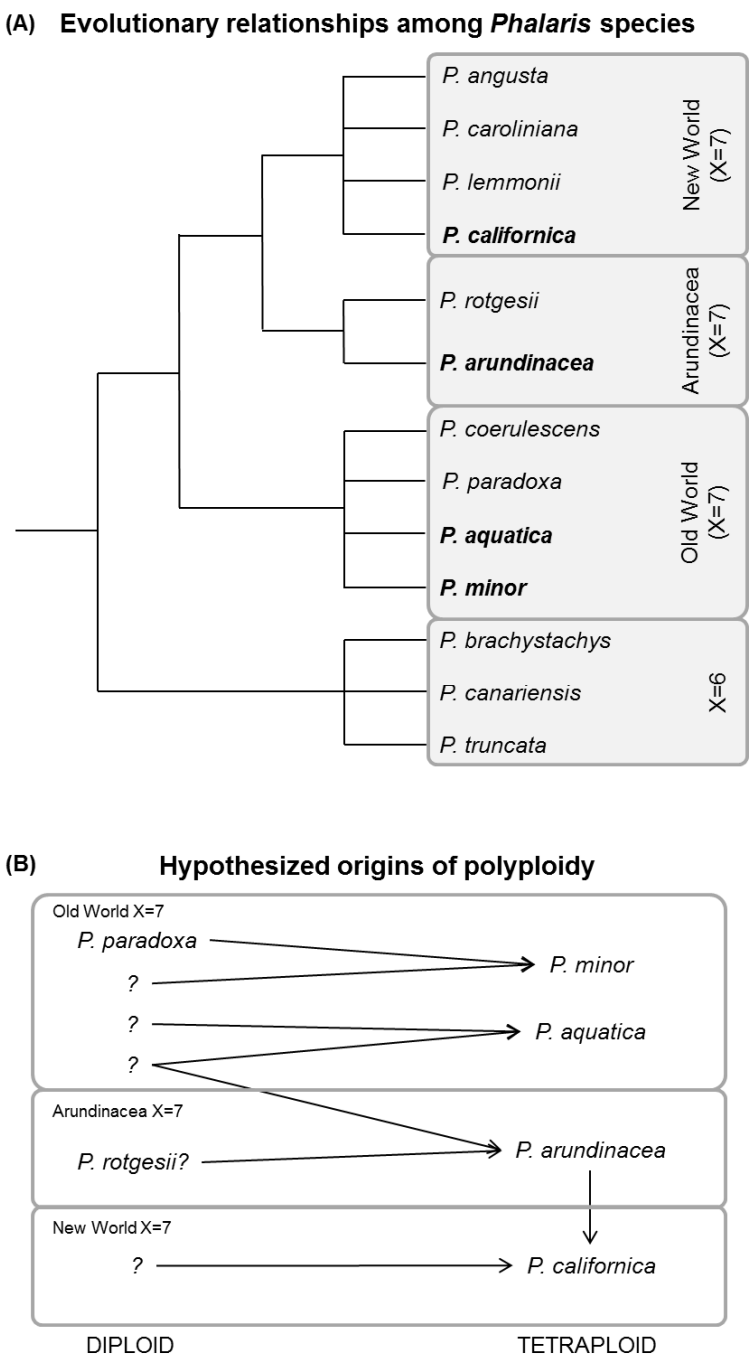


Figure 8. The evolutionary history of species within the grass genus *Phalaris* (A) and the hypothesized origins of polyploid species in the genus (B). From: Visser & Molofsky 2015; *Am. J. Bot*. 102: 36 – 49

1.2.3 B. Acacias as model systems for understanding invasions and impacts

Together with some other key groups which are under ongoing investigation (invasive birds, the harlequin ladybird, *Xenopus laevis* and environments such as urban areas and agricultural contexts), Australian acacias provide a superb model system for exploring the full range of challenges and management options associated with introduced species. This group of plants has featured prominently in research at the C·I·B since its launch. In 2015, this group yielded several important research products and collaborations.

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.

The chronicle of a tree well-travelled

The Australian tree *Acacia saligna* has been moved around for world for well over a century. It is a hardy, drought resistance species that grows in a wide range of environments, including saline and nutrient-poor soils. It is commercially important in the drier areas of outback Australia, where it is virtually impossible to grow crops of agricultural value. Its resistant nature and use as fodder for livestock and biomass for fire has resulted in a long history of dissemination via the Australian Tree Seed Centre that began in the early 1960s. The species is listed as invasive in South Africa, parts of the Mediterranean Basin (e.g. Portugal, Italy, Spain), California (USA), Ethiopia, and Israel. Based on morphological characteristics, three subspecies lineages have been tentatively identified within A. saligna.

Work by C·I·B researchers and students and co-authors from Australia looked at native populations in Australia and introduced populations from South Africa. This work identified significant genetic divergence between South African populations and all native populations from Western Australia. Statistical parsimony revealed a level of genetic distinctness between South African and other *A. saligna* populations that exceeded the divergence previously identified between acacia subspecies and, in some instances, even species. Nuclear gene regions and ten microsatellite loci were however able to link South African populations with two cultivated populations of *A. saligna* in Australia. Further qualitative research on the use of the species in Australia suggested that the unique genotype arose as a result of cultivation and associated breeding programs on the species in Australia.

More recently, a follow up study undertaken by C·I·B PhD student Genevieve Thompson and co-workers expanded the sampling area to include introduced populations in Israel, Italy, New Zealand, Portugal, Spain, the USA and non-native populations from the eastern parts of Australia. This work confirmed the unique nature of the genetic entities present in South Africa. Despite the identification of all three lineages of *A. saligna* in globally introduced populations, no single genetic entity was present in all introduced populations or countries. Bayesian assignment analysis did however identify admixture within non-native Australian populations and populations from Israel, Italy and Portugal. On the basis of shared nuclear sequences and microsatellite assignment tests, the following subspecies lineages were identified in the introduced ranges as follows: *A. saligna* subspecies lineage '*lindleyi*' in eastern Australia, Portugal and the USA; subspecies lineage '*saligna* + *pruinescens*' in Italy, Portugal and South Africa; and subspecies lineage '*stolonifera*' in wild populations in Western Australia and introduced populations in Portugal, Israel and Spain (Figure 9).

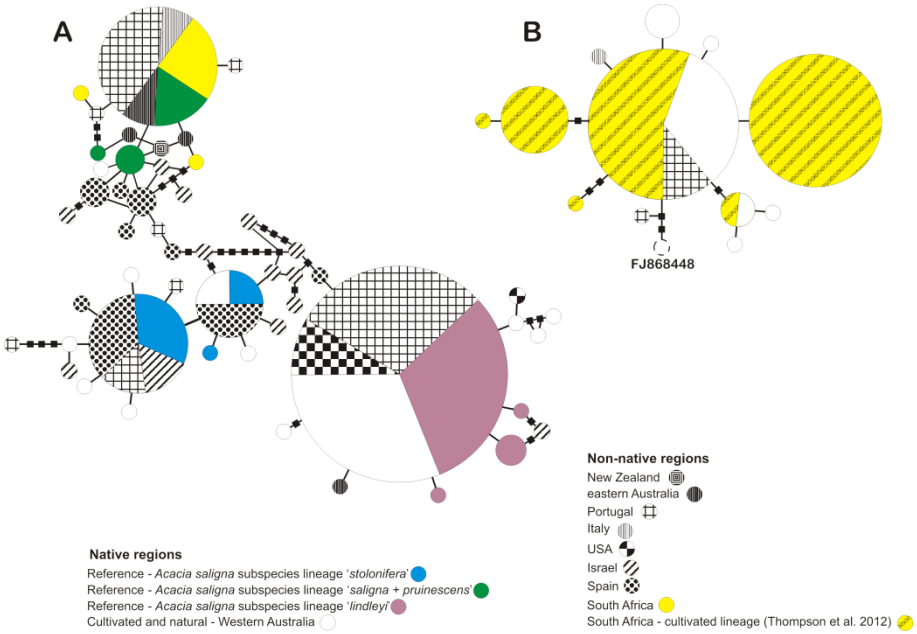


Figure 9. Maximum parsimony phylogenetic network representing the relationships among external transcribed spacer ETS sequences for 120 individuals of *Acacia saligna*. From: Thompson *et al*. 2015; *J. Biogeogr*. 42: 305–314

Given the presence of a variety of subspecies lineages in regions globally, the authors concluded that it was unclear how effective management of invasions in one region may be successfully applied in other regions. For instance, biological control agents successfully used in South Africa may be effective against similar genetic entities in Portugal, but the same control agents lack efficacy against dissimilar genetic entities present elsewhere. Further work is needed to conclusively link the relative extent of invasions to genetic differences, and to determine whether genetic novelty can explain the widespread invasions of *A. saligna* observed in South Africa and Portugal (Thompson *et al*. 2015; *J. Biogeogr*. 42: 305–314).

Learning lessons from well-advanced wattle invasions

Problems associated with invasiveness of non-native tree species used in forestry are increasing rapidly worldwide and are most severe in areas with a long history of plantings. Lessons learnt in areas with long histories of plantings and invasions may be applicable to areas with shorter planting histories. Most research towards understanding such tree invasions has focussed on *Pinus* species, though all groups of trees that have been widely used in forestry are invasive to some extent. C·I·B core team members Dave Richardson, Jaco Le Roux and John Wilson undertook a study to explore the experience with Australian *Acacia* species ("wattles") (Richardson *et al*. 2015; *Sth Forests* 77: 31–39).

Unlike some other groups of trees, no particular set of traits clearly separates highly invasive from less- or non-invasive wattles. All species that have been widely planted over a long period have become invasive; the extent of invasions is largely a function of human usage. These findings imply that propagule pressure together with residence time are the main drivers of invasiveness in wattles

(many factors mediate this driver, including fire, forest clearance and soil disturbance). There have been massive plantings of wattles in South East Asia in the last few decades - large-scale invasions are inevitable in this region unless pro-active management is implemented quickly (Figure 10).

The history of wattles in South Africa highlights the need for such proactive management. Wattles were of considerable net value to the South African economy immediately after introduction. However, the costs of wattle invasions increased over time to such an extent that (certainly over the last few decades) these costs exceed the benefits derived from the forestry industry. Wattles now dominate many natural ecosystems.

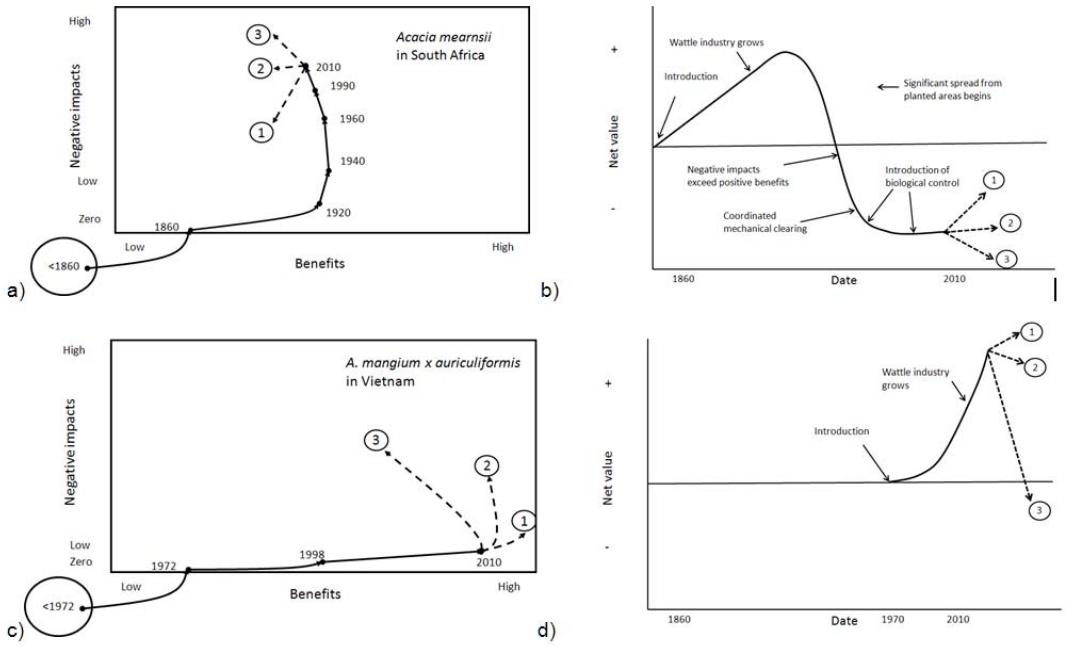


Figure 10. Historical and possible future costs and benefits associated with Australian *Acacia* introductions. Panels a & b summarize insights from *A. mearnsii* in South Africa. Panels c &d suggest likely trajectories for *Acacia mangium* x *auriculiformis* in South East Asia. From: Richardson *et al*. 2015; *Sth Forests* 77: 31–39

The authors proposed several interventions to prevent a similar pattern in South East Asia and to ensure the sustainability of plantation forestry based on wattles in the region. A spatially-explicit assessment of invasion risk is required, and a monitoring system should be implemented. Cost-benefit analyses (that consider the full suite of perspectives relating to costs and benefits) need to be applied to determine the need for sustainable mitigation methods. Options for reducing potential invasiveness should be implemented; these include biological control targeting seed production (very good success has been achieved in South Africa) and the use of sterile cultivars.

Feathered friends help rooikrans spread

Birds are important role-players in the spreading of seeds from the invasive tree Rooikrans (*Acacia cyclops*). The birds are especially attracted to the bright red fleshy stalks that surround the seeds. Between 1991 and 2002, conservation authorities used biological control to reduce Rooikrans stands

and seed production. While the biological control was successful in reducing seed production, the question now remains – will birds stop visiting trees with low seed numbers, or will they return and continue to spread Rooikrans?

A recent study by former C·I·B PhD student Thabiso Mokotjomela, together with John Hoffmann (University of Cape Town) and C·I·B core team member Colleen Downs, used field experiments with caged birds to see whether birds disperse the seeds from remaining rooikrans stands (Figure 11).

Figure 11. Dr Thabiso Mokotjomela conducting experiments in a dense stand of *Acacia cyclops.* Photo: Thabiso Mokotjomela

The study found that birds indeed removed and dispersed seeds from remaining Rooikrans stands. He further found that seeds eaten by the granivore Red-eyed Dove (*Streptopelia semitorquata*) and the frugivores Knysna Turaco (*Tauraco corythaix*) and Red-winged Starling (*Onychognathus morio*) had higher germination rates, but not the granivore Laughing Dove (*Streptopelia senegalensis*). Granivores are animals and birds that feed on seeds, while frugivores are fruit eaters. Thabiso also examined how the body size of birds influence the germination of seeds. No relationship was found between the birds' body sizes and the time for which the seeds stayed in the gut. This means that the birds' body sizes could not be used to predict the length of seed retention time in the gut and thus how far seeds might be dispersed (Mokotjomela *et al*. 2015; *Ibis* 157: 449–458).

Thabiso explains: "*Even though there were less seeds available for the birds after using biological control, the birds continued to eat and spread the remaining Rooikrans seeds. Our next step is to use mini GPS transmitters to track the movements of bird species that eat Rooikrans seeds. This will show us where and how far the birds spread the seed*".

1.2.4 C. Detection, demonstration, responses and remediation

South African alien species databases – are they useful?

Information on how or why alien species arrive in a country can help prevent future introductions. Such information is usually stored in databases, and in many parts of the world, these databases are used for research and management. In South Africa, alien species databases are available for many types of organisms (like mammals, birds and plants) but it is unknown whether South African databases can be used to the same extent as the databases of other countries.

C·I·B PhD student Katelyn Faulkner and colleagues assessed the information content of South African alien species databases to see how it compares with databases from other countries.

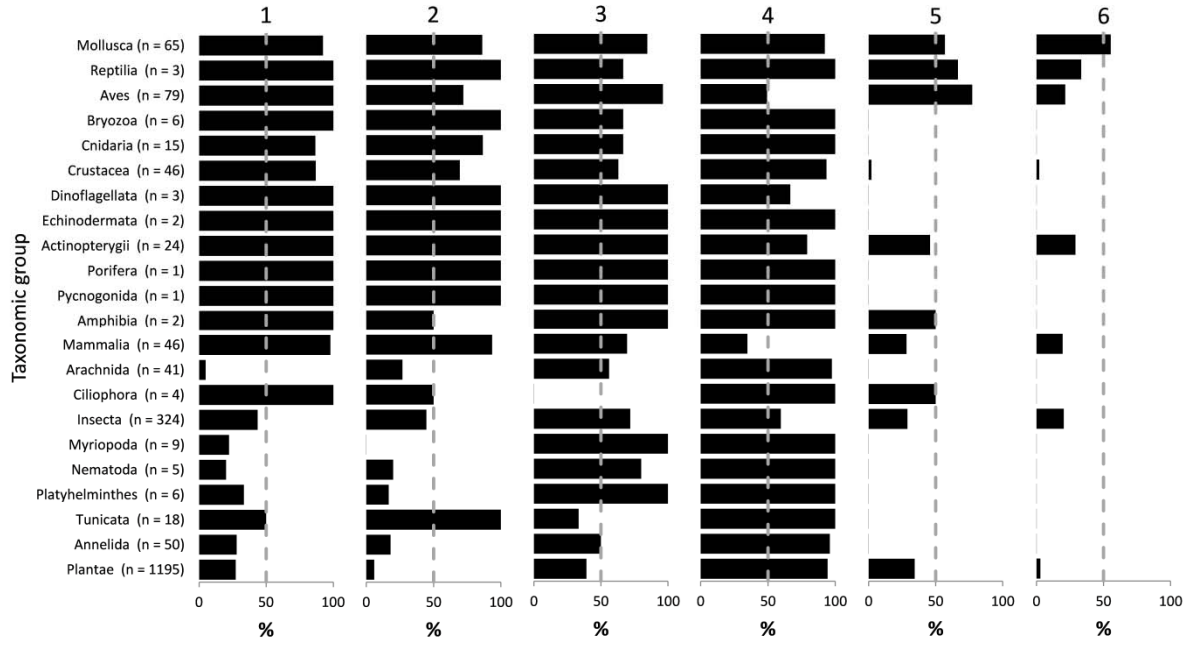


Figure 12. Percentage of the total number of alien taxa per taxonomic group for which data on (1) pathway of introduction, (2) date of introduction, (3) region of origin, (4) distribution, (5) invasion status and (6) all the aforementioned categories were provided. The number of species in each taxonomic group is given in round brackets and taxonomic groups are arranged according to descending data comprehensiveness (i.e. the number of categories for which data is available for greater than 50% of taxa) (From. Faulkner *et al.* 2015; *Bothalia*, 45, doi: 10.4102/abc.v45i1.1103)

They found that the information provided by South African databases is good for some organisms (e.g. birds), but is poor for others (e.g. insects), and that useful information is often not provided (e.g. invasion status data). South African databases also have less information than many of the databases for other countries (Faulkner *et al.* 2015; *Bothalia*, 45, doi: 10.4102/abc.v45i1.1103) (Figure 12).

Katelyn and colleagues came up with eleven recommendations to address the gaps they identified. One recommendation is that a single, standardized meta-database be developed that would facilitate cross-taxon comparisons. According to Katelyn, "*A meta-database will make information on alien*

species more accessible, and will have a standard format which will facilitate research within and across different types of organisms."

Public surveys contribute to rose-ringed parakeet research

Rose-ringed parakeets (*Psittacula krameri*) are the most invasive parrot species in the world and have already invaded 35 countries on five continents. In South Africa, the first sightings were noted in the 1970's with strongholds predominantly in Gauteng and KwaZulu-Natal. Today populations are also known in Cape Town, and Steytlerville in the Eastern Cape. Rose-ringed parakeets are a generalist species, which can thrive in a range of habitats and feed on a variety of food items. They nest in cavities, and where food and nest sites are not limiting these birds have the capacity to reproduce successfully and rapidly.

C·I·B core team member Colleen Downs and post-doctoral fellow Lorinda Hart undertook a study of the current distribution of rose-ringed parakeets, *Psittacula krameri* (Scopoli, 1769) in the Durban Metropolitan area of eThekwini (Hart & Downs 2014; *African Zoology* 49:283-289). Newspaper articles, newsletters and networking with local bird clubs were used to identify roost sites and areas where parakeets were observed. Surveys were then conducted to determine parakeet presence in and around these areas.

The South African Bird Atlas Project 2 (SABAP2) indicates that the parakeets currently occupy 475 km^2 of the 2292 km^2 of the Durban Metropolitan area. Surveys from this study indicate an occupancy of *c.* 730 km^2. Such data comparisons indicate that rose-ringed parakeets are expanding their distributions. This could have negative consequences on native bird species, particularly cavity nesters. Rose-ringed parakeets are currently associated with urban areas, but could potential expand as populations grow.

Promising prospects for the eradication of Melaleuca quinquenervia in South Africa

The discovery of a clump of broad-leaved paper-bark trees (*Melaleuca quinquenervia*) in 2009 by a field ranger lead to an exciting study on this global wetland invader (Jacobs *et al.* 2015; *BioInv. Records* 4: 53–59). CapeNature employee and part-time C·I·B student Llewellyn Jacobs assessed the distribution of the plant across South Africa and examined the prospects for the eradication of this well-known invasive species from the region.

Working together with the South African National Biodiversity Institute's Invasive Species Programme, Llewellyn extracted localities from herbarium specimens and targeted land managers and researchers to get information of where these plants may be. He found seven records in South Africa of which two populations are naturalised (alien species that form populations that persist, and reproduce, for at

least 10 years without intervention by people) (Van Wyk & Jacobs 2015; *Afr. J. Aquat. Sci*. 40: 299-306). The *Melaleuca quinquenervia* working group then targeted one of the naturalised populations for clearing to see which characteristics hinder or favour its eradication, and whether it is a cost effective management option. After initial clearing and herbicide treatments in 2009, the population were monitored for a six-year period until 2014. Results showed that by removing seedlings before maturity and by chemical treating regrowth from the stumps, the population can be eradicated. The project has cost R532 000 with the highest input during the initial clearing activities in 2010. Expenses then dropped to R20 000 per year in 2013 and 2014.

This study shows promising results for efforts to protect wetlands affected by small populations of paper-bark trees at a relatively small cost, especially once efforts reach a maintenance phase" says Llewellyn Jacobs, who is currently a Scientific Technician with CapeNature's Scientific Services. He adds "*It is a concern however that the recent national invasive species legislation lists the broad-leaved paper bark as category 1b (requiring compulsory control), but national heritage trees are exempted from this. This tree is listed as one of the global top 100 most invasive species, and if eradication or control is attempted, it may be hindered by this listing.*"

Alien urchin no longer a concern for the West Coast

It is important that lists of invasive and alien species be updated regularly, but sometimes it can be difficult to decide when a species should be removed. A recent study by C·I·B student Clova Mabin and supervisors Tammy Robinson and John Wilson considered the case of the Chilean black urchin, *Tetrapygus niger* (Mabin *et al.* 2015; *Bioinvasions Records* 4: 261-264). This urchin was first detected in an aquaculture dam on a diamond mine in Alexander Bay on the West coast of South Africa in 2007. It is thought that this species was accidentally introduced with immature oysters which were imported by the oyster farm that utilised the dam.

Although this species has not been recorded as alien elsewhere in the world, the presence of this urchin caused concern because of the role that this species plays in its native range. Back home in Chile, the urchin feeds on algae, particularly kelp, and is capable of converting healthy kelp populations to barren landscapes. Kelp forests dominate the West coast and have both ecological and economic value to South Africa. If this species were to spread from the aquaculture dam, this important resource as well as abalone farming operations in the region could be threatened. As a result of these potential economic and ecological impacts, *T. niger* was listed as a target for eradication under South Africa's National Environmental Management: Biodiversity Act of 2004 (NEM:BA). In an effort to support the management of this species, the study undertaken by the C·I·B team involved the re-survey of the affected and neighbouring aquaculture dams, as well as intertidal and subtidal searches of the surrounding coast (Figure 13). The latter areas were of concern as runoff from the dams was believed to have reached the shoreline during routine aquaculture operations and this could have transported urchin eggs to the coast.

Despite intensive fieldwork Clova and colleagues found that *T. niger* was absent from all sites, despite the presence of a healthy population of native urchins *Parechinus angulosus*. There was also little indication of urchins grazing on kelp stipes. The study recommended that *T. niger* be removed from the South African list of introduced marine species, but that it be retained on the list of prohibited species and on a watch list until there is an absence of vectors to South Africa.

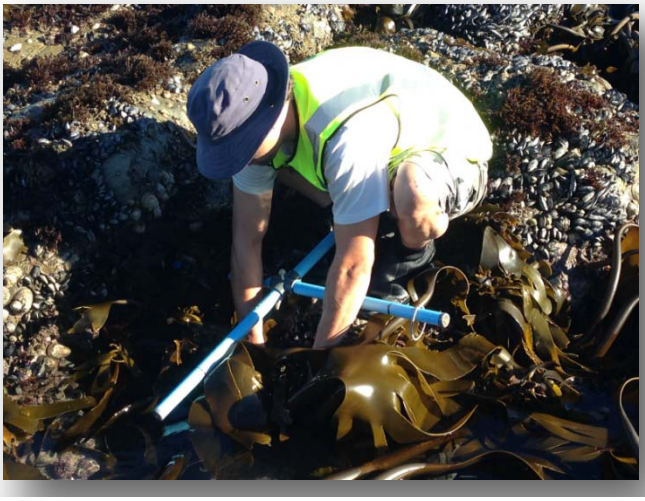


Figure 13. A field worker searching for the urchin *Tetrapygus niger* along the open coast. Photo: Clova Mabin

1.2.5 D. Global environmental change and ecosystem services

Drivers of global change: interactions of invasive species and habitat loss

Global biodiversity is declining at an alarming rate. Causes of these declines include the destruction of natural habitats as a result of human development, and the introduction of non-native species. The interaction of these processes can have serious consequences for the functioning of natural systems and are of particular concern in freshwater systems. One method to investigate the impact of a non-native species on the surrounding environment is to measure its resource use, for example, its consumption of native species as prey. This can also be investigated over a range of habitat types and complexities to see how the loss of habitat might change this impact of the invasive species (Figure 14).

A study led by C·I·B post-doctoral associate Mhairi Alexander, involving C·I·B staff and collaborators at SAIAB in Grahamstown, examined the impacts of an invasive fish species towards a prey species under a series of habitat complexities that simulated habitat loss (Alexander *et al.* 2015; *Environ. Biol. Fish*., 98:477–486). Habitat complexity refers to the variety of shelter that is available to fish and other aquatic species in a river or water body and is important as it provides shelter, food and nursery habitats.

The study examined the resource use of the invasive freshwater fish, the largemouth bass (*Micropterus salmoides*), in simulated reed bed habitats that decreased in density as they would through stages of habitat loss (Figure 15). By using a prey item, the guppy *Poecilia reticulata*, the study found that only slight decreases in habitat complexity cause an increase in prey consumption across a density of prey.

Figure 14. Masters student Lubabalo Mofu collecting invertebrates in the Rondegat River. Luba has since graduated and is pursuing a PhD with C·I·B support. Photo: Olaf Weyl

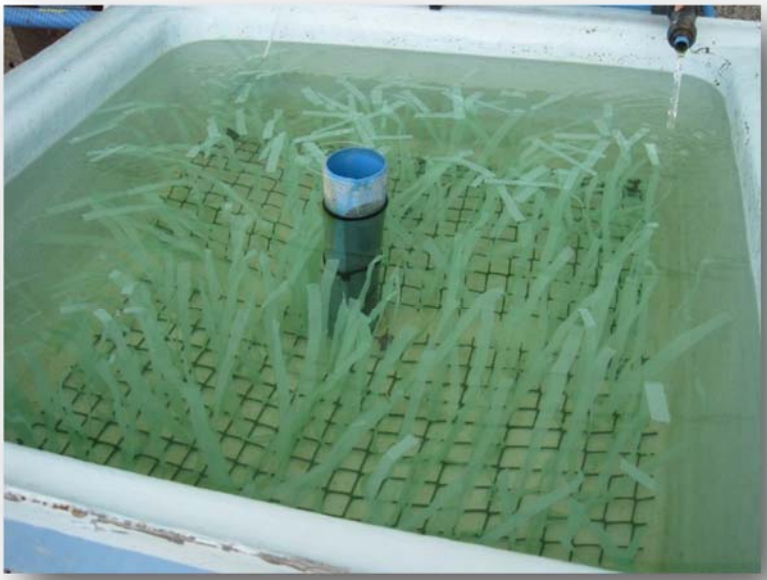


Figure 15. An experimental tank with an example of intermediate densities of the simulated habitat complexity. Photo: Mhairi Alexander

"*What this study has highlighted is that when two drivers of global change, that is habitat destruction and invasive species, are considered in combination, their effects are potentially exacerbated."* says Mhairi Alexander, lead researcher of the study. She adds that "*the study has important implications*

for managers and policy makers to invest resources in cost effective mitigation of both invasive species but also protection of important habitats."

Reconstructing the invasion routes of a major agricultural pest

In a rapidly changing world, the ability to prevent invasions by intercepting foreign organisms or by implementing quarantine measures is critical. Few studies however investigate the effectiveness of such measures in preventing new or ongoing invasions.

A recent study involving several C·I·B-affiliated researchers genetic markers to determine the population genetic structure (the movement of individuals between different sampling localities) and the potential routes of invasion (the path taken to the introduced range) in the Mediterranean fruit fly (*Ceratitis capitata*) (Figure 16) (Karsten *et al.* 2015; *Diversity Distrib*. 21: 813-825).

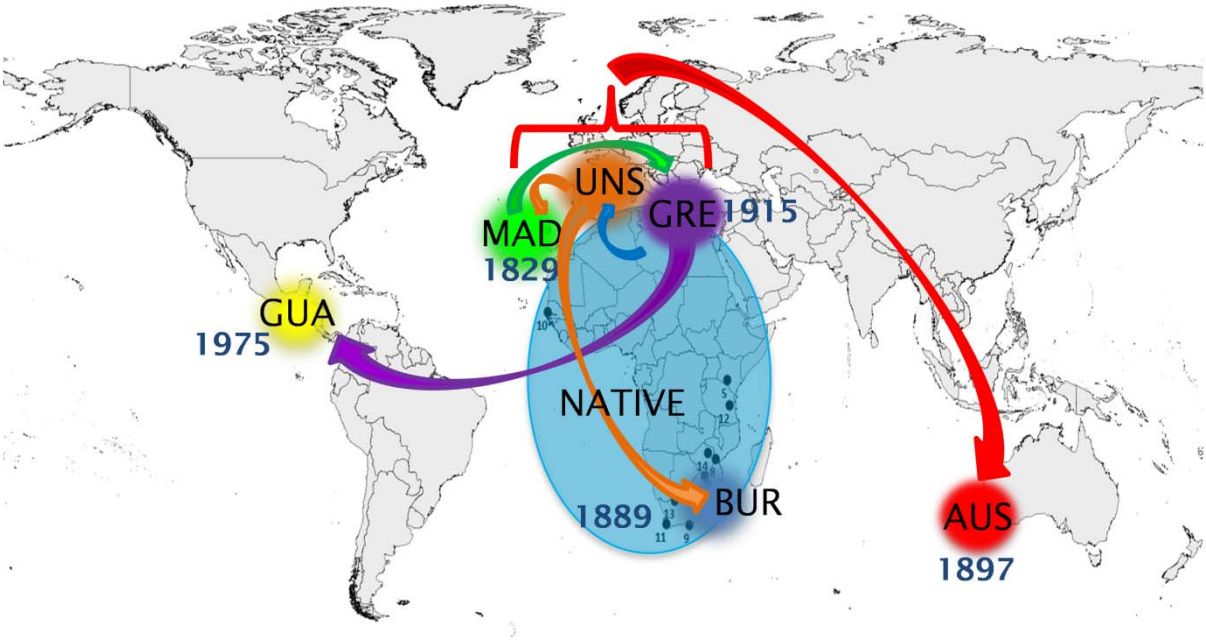


Figure 16. The worldwide route of invasion of the Mediterranean fruit fly (*Ceratitis capitata*). Arrows indicate the most likely route of invasion coloured circles represents a sampling area in our data and the bracket indicates admixture between populations (GUA = Guatemala, MAD = Madeira, GRE = Greece, AUS = Australia, NATIVE = All African populations, UNS = Unsampled location, BUR = Burgers Hall). Dates indicated are for the first record available. From: Karsten *et al.* 2015; *Diversity Distrib*. 21: 813-825

Results showed that the flies move freely between locations on the African continent, but not from their African native range to the introduced range. Making use of Approximate Bayesian Computations (ABC), the study showed that the likely invasion pathway of the fly was an initial colonization of Europe from Africa (the native range) and a secondary colonization of Australia from Europe. The authors

further showed an introduction from Europe to the Americas and a back-introduction into South Africa from Europe.

"Given the lack of new introductions into colonized, non-African locations despite growing trade, it is clear that quarantine and interception measures for export consignments from Africa have been largely successful." says Minette Karsten, C·I·B-funded PhD student who was lead author of the study. She adds *"A concern, however, is the high levels of movement of flies over the African continent. This does not bode well for the fruit industry on the continent, especially in the light of preventing new invasions into previously pest-free regions."*

Impact of invasive alien birds on seed germination

A study by C·I·B student Vuyisile Thabethe and colleagues assessed how the germination of invasive seeds are influenced after being eaten by indigenous, Knysna (*Tauraco corythaix*) and purple-crested (*Gallirex porphyreolophus*) turacos, and invasive, rose-ringed parakeets (*Psittacula krameri*). To test this, fruits of four invasive alien plants: bugweed (*Solanum mauritianum*), camphor (*Cinnamomum camphora*), guava (*Psidium guajava*), and mulberry (*Morus alba*), were fed to the rose-ringed parakeets and turacos. The seeds from each bird's excreta or regurgitation were removed and planted in separate trays (Thabethe *et al.* 2015; *Biological Inv*. 17: 3029-3039).

Vuyisile found that seeds passing through the gut passage of the two indigenous birds' had higher rates of germination. In contrast, seeds passing through the digestive tract of rose-ringed parakeets had lower rates of germination. The results suggest that turacos are seed dispersers of these fleshy-fruited invasive alien plants, while rose-ringed parakeets are seed predators. Damage to the seeds can be caused by the parakeets crushing them while feeding and/or destruction of viable seeds in the digestive tract.

"Although parakeets are not promoting the spread of invasive alien plants, indigenous plants may suffer similar fates and have reduced germination rates," says Vuyisile Thabethe, lead author of the study. She adds, *"This is perhaps one of the first studies highlighting the destructive behaviour of rose-ringed parakeets on indigenous fruiting plants in South Africa."*

1.2.6 E. Human dimensions

Pathways of biological invasions

A study led by C·I·B associate Franz Essl (University of Vienna), and involving several C·I·B researchers and a large international team explored the current level of understanding regarding pathways of invasions (Essl *et al.* 2015; *BioScience* 65: 769-782). Invasions of alien species begin with the human-assisted movement of living individuals or propagules across biogeographic barriers (Figure 17). As a result, the contributions of specific pathways to introduction and subsequent invasion—and the changes in the importance of pathways over time—are receiving increasing attention from scientists and policymakers.

This research provides a comprehensive assessment of the role of introduction pathways in causing biological invasions. In particular, the study reviewed current knowledge, highlights recent advances, identifies pitfalls and constraints, and discusses key challenges in four broad fields of pathway research and management: pathway classification, application of pathway information, management response, and management impact. The authors also provide recommendations for a research agenda with particular focus on emerging (or neglected) research questions and present new analytical tools in the context of pathway research and management.

"Improving the understanding of introduction pathways is essential for advancing the management of alien species", says Franz Essl. *"We thus believe that the guidance provided in this publication will be useful for scientists and alien species managers alike."*

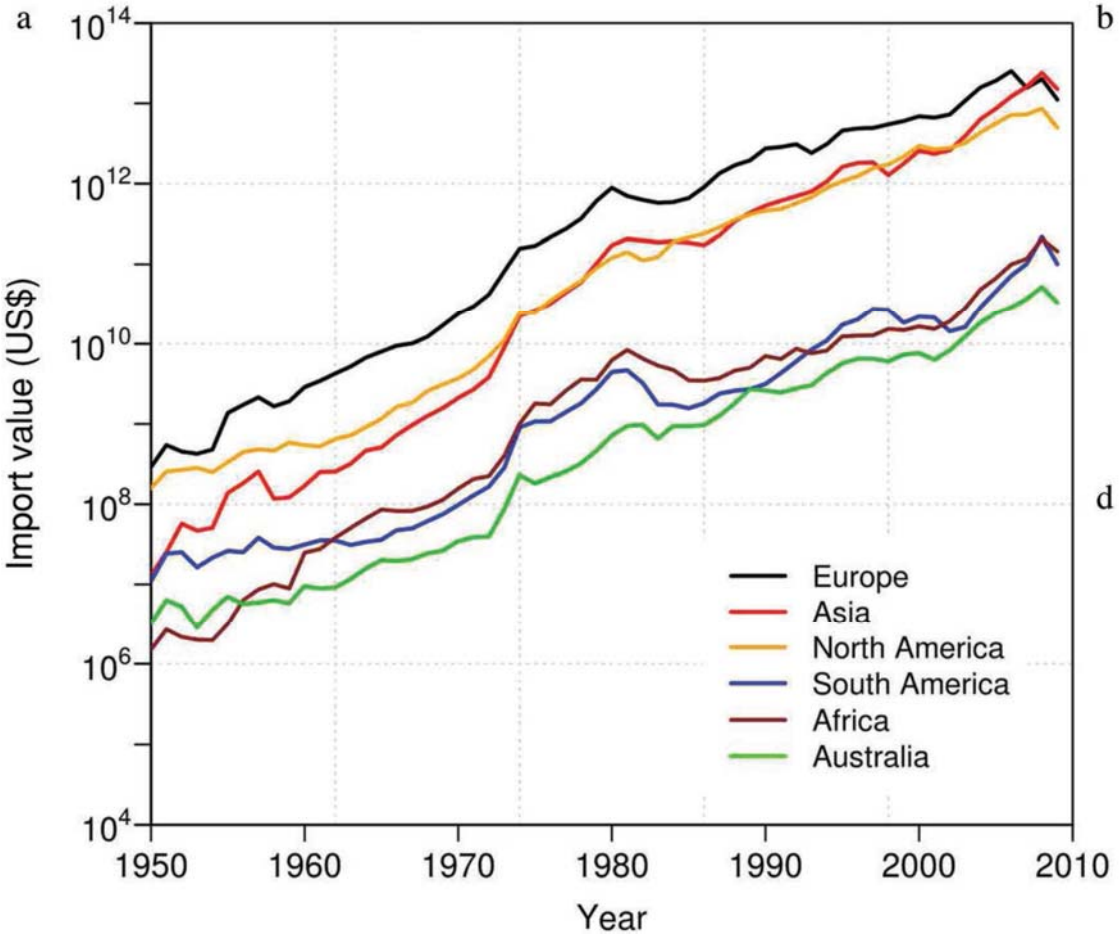


Figure 17. The role of bilateral trade in explaining biological invasions. Given are the temporal trends (1950–2009) of total import volume of continents, which is a proxy for propagule pressure of alien species. From Essl *et al.* (2015; *BioScience* 65: 769-782)

A costly affair – pine invasions in protected areas

Protected areas (PAs) are a key intervention for conserving biodiversity and ecosystem services. A major challenge for PAs is the control of invasive alien plants that spread into PAs from surrounding areas such as forestry plantations. The links between invasions and different plantation sources are

poorly understood, making it difficult to assign responsibilities for control costs (Figure 18). To address this issue, C·I·B post-doctoral associate Matthew McConnachie and co-workers used a new quasi-experimental method to estimate the effect of plantations of invasive pines (*Pinus* species) on the spread of these trees into PAs in the Cape Floristic Region (McConnachie *et al.* 2015; *J. Appl. Ecol.* 52: 110–118).

They found that 51% of PA pine invasions were caused by nearby plantations. Costs of controlling invasive pines in the study area totalled 98 million Rand between 2001 and 2012. It could cost between 273 and 916 million Rand, and take between 34 and 113 years, to clear the remaining pines in the study area, depending on rates of spread and cost-effectiveness of control. The results provide a starting point for estimating the contribution of plantation forestry to invasions in protected areas in the Cape Floristic Region.

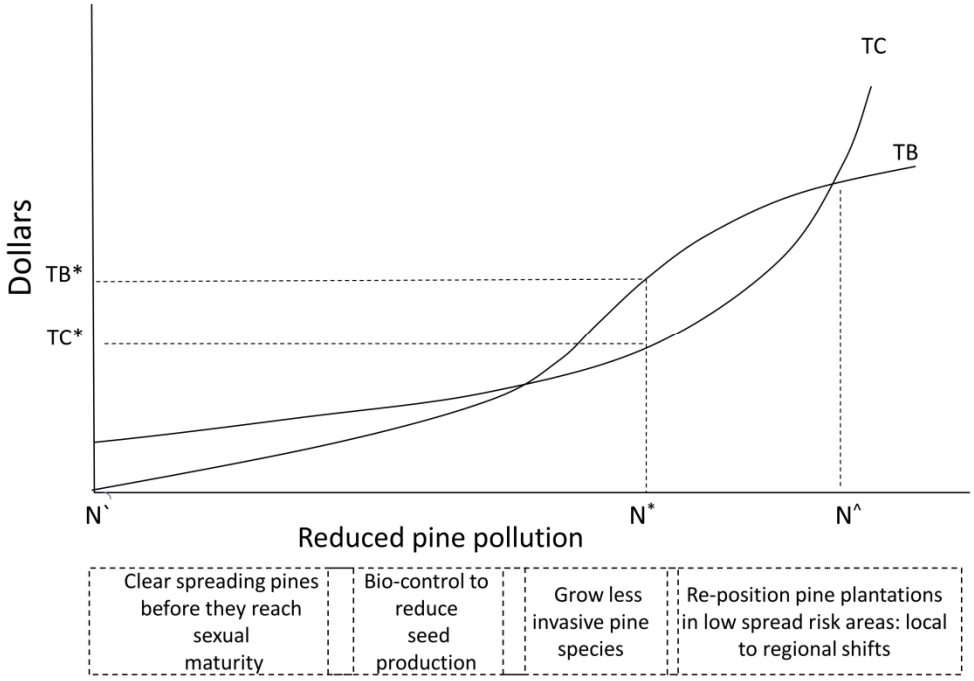


Figure 18. A hypothetical example of trade-offs faced by policymakers in deciding on the socially optimal target for reducing the spread of pine trees from pine plantations. From: McConnachie *et al.* 2015; *J. Appl. Ecol.* 52: 110–118

Getting to grips with decision-making in invasive plant management

Making decisions about the clearing of invasive alien plants is not an easy process. Despite a plethora of academic literature and practical examples, managers continue to rely on experience and anecdotes instead of using scientific findings. This so-called "science-practice gap" receives a lot of attention in the scientific literature, with natural resource managers often being criticized for not using

scientific evidence when making decisions in their day-to-day operations. However, little regard is given to the practical constraints that managers experience in their work environments.

A study led by former C·I·B PhD student Phumza Ntshotsho, involving C·I·B staff and collaborators at the CSIR, assessed the use of scientific evidence in the management of invasive alien plants in South Africa (Ntshotsho *et al.* 2015; *Biol. Conserv*. 184: 136-144).

Using the national Department of Environmental Affairs' Working for Water (WfW) program as a case study, the researchers showed that there are several factors that determine the extent to which science is used in decision-making. For example, the institutional context within which decision makers operate plays an important role. Organizational structure, policies, priorities and capacity influence, and may even limit, the use of scientific evidence when making decisions.

"Our findings highlight the importance of conducting research with the end user in mind. Being cognizant of other factors that may affect the practical utility of our science may encourage closer collaboration with decision makers" says Phumza. *"Co-producing knowledge with end users would increase the potential for its application, which would ultimately mean we are doing impactful science", she concludes.*

Anglers contribute to invasive bass research

Information on how invasive fish species enter and spread in aquatic ecosystems of southern Africa is critical for managing such invasions. This is particularly important for alien sport fishes that are "conflict species" because they have economic and recreational value. Black bass (a collective term for species belonging to the genus *Micropterus* such as largemouth bass *M. salmoides* and smallmouth bass *M. dolomieu*) are good examples of "conflict species" because they are popular angling species, but also have impacts on native ecosystems. To manage such conflicts, South African legislation set aside activities, including catch and release angling, in areas where black bass is already established.

C·I·B core team member Olaf Weyl and his international team worked with the South African Bass Angling Association (SABAA), the Zimbabwe National Bass Federation (ZNBF) and the Bass Anglers Sportsman Society (BASS) in the United States to evaluate the invasion status of black bass in southern Africa. The team made use of data from 14,890 days of tournament fishing (11,045 days from South Africa and Zimbabwe; 3,845 days from the United States).They mapped the distribution of black bass using records from tournaments in Botswana, Mozambique, Namibia, South Africa, and Zimbabwe. The team compared (1) catch rates (indicator of abundance) and (2) fish weights (indication of fish size) from native and non-native ranges.

The study (Hargrove *et al.* 2015; *PLoS One* 10 e0130056) found no significant differences between catch rates, average daily bag weight, or the average fish weight between countries.

"That means bass populations in southern Africa reached comparable sizes and numbers relative to the waters where they are native," says Olaf Weyl. He adds, *"Given the minimal cost associated with*

data collection (i.e. tournament organizers collect records); the standardized nature of tournaments, and consistent bias (i.e. angling for the biggest fish in a population), the use of recreational angler data can be a novel approach for determining the status and distribution of invasive sport fish."

The negative impacts of Prosopis invasions outweigh its benefits

Many invasive species provide both benefits and costs to society and the environment. These benefits include aesthetic values, but also provide resources such as timber, fuelwood, fodder and food. However, these invasive species can have costly consequences. For example, they reduce the supply of ecosystem services such as water and grazing, reduce native biodiversity and have negative impacts on local economies. Species that have both benefits of and costs can lead to conflicts of interest and have often hindered effective management.

Work by C·I·B PhD student, Ross Shackleton, explored one such conflict-species: *Prosopis* or mesquite. Interviews were conducted with several communities to compare the household use and perceptions of mesquite as compared to native trees (Shackleton *et al.* 2015; *For. Ecosys.* 2: 16 doi:10.1186/s40663-015-0040-9).

Most households use both native trees and/or mesquite for fuelwood. However, the majority of stakeholders across ten communities in the Northern Cape still use native trees more than mesquite. This suggests that its direct use value for households is not as important as previously thought, and that native trees, that mesquite displaces, are still more important in the area. This was because fuelwood from native trees was seen as being of a better quality. The reasons for stakeholders to prefer native trees include: coals from native trees are longer lasting; wet mesquite wood gives off odorous smoke; large thorns make it difficult to harvest mesquite; and dried mesquite wood is particularly susceptible to a borer beetle which turns it into pulp faster than in wood from native species. The study further found that the reliance on both native trees and mesquite is decreasing as the electrification of towns increase.

"This study showed that the impacts of mesquite exceed the benefits, and that conflicts of interest surrounding mesquite are not as high as previously thought. The improved management of mesquite, for example, through biological control agents, needs to be implemented to reduce the costs of invasion and possibly improve benefits" explains Ross Shackleton.

2 Education and training

2.1 Objectives

Recognising the enduring requirement for improving the demographic, gender and age profiles of the South African scientific community, and for retaining excellence in the science system, the C·I·B will continue to support 3rd and 4th year students who meet either (and increasingly both) of these requirements. The main idea is to draw students into the Centre's sphere of influence and to encourage them to think about the research done by the Centre as a rewarding career path.

2.2 Progress

In 2015, the C·I·B supported 68 students and 16 post-doctoral associates (see Table 2 and Table 3). For the first time we had seven South African post-doctoral associates (44% of the total), the majority of whom were graduates of the C·I·B programmes, reflecting the success of the CoE at 'growing its own timber'. Altogether, the C·I·B hosted 21 foreign students and post-doctoral associates from African countries Madagascar, Rwanda, Uganda and Zimbabwe, and from Australia, Canada, Chile, Germany, Ireland, Italy, Portugal, Spain the UK and the USA.

Table 2. Demographic information on the 2015 student and post-doctoral associate group

All supported students	**68**		**All supported post-doctoral associates**	**16**	
Academic level					
Honours/4th year B. Agric.	7	10%			
Masters	35	52%			
PhD	26	37%			
Gender			**Gender**		
Male	32	48%	Male	7	44%
Female	36	52%	Female	9	56%
Student demographics			**Student demographics**		
Black	35	52%	Black	1	6%
White	33	48%	White	15	94%
Funding level			**Funding level**		
Full	31	45%	Full	8	50%
Partial	18	27%	Partial	1	
Independent	19	28%	Independent	8	50%
Citizenship			**Citizenship**		
South African	57	84%	South African	7	44%
Foreign	11	15%	Foreign	9	56%

2.2.1 Postgraduate training

A full list of students and post-doctoral associates supported by the Centre and their progress in 2015 can be found in Appendix A.2. Graduations in 2015 included seven honours/4th year (four black, three white), 12 Masters (seven black, five white) and 7 PhDs (three black, four white) (Figure 19).

Figure 19. C·I·B doctoral graduates in 2015. Clockwise from lower left: Katelyn Faulkner (UP), Caswell Munyai (UniVen), Matthys Strydom (SU), Ony Minoarivelo (SU), Jessica Allen (SU), Uninjee Poonan (Wits), Ross Shackleton (SU). Information on the current whereabouts of these graduates can be found in Table 3 below.

2.2.2 Awards

Giovanni Vimercati (PhD candidate, advisor: Dr John Measey)

Giovanni was awarded the C·I·B travel prize for the best PhD presentation at the C·I·B's Annual Research Meeting in November 2015, for his talk and infographic titled "Game of Toads: is winter coming? Studying guttural toad eradication in Cape Town through an individual-based model". He plans to use the award to travel to Réunion Island to work with researchers on another invasive population of guttural toads. Giovanni was also awarded the prize for best PhD-level presenter at the Department of Botany and Zoology's Annual Meeting.

Susan Canavan (MSc candidate, supervisor: Dr John Wilson)

Susan was awarded the C·I·B travel prize for the best Masters presentation at the C·I·B's Annual Research Meeting in November 2015. Susan plans to attend a *Phragmites* workshop in Sardinia in April 2016, as well as organize an additional one-day focus group to discuss the invasiveness and management of large-statured grasses more generally, including species like *Phragmites* spp., *Arundo*

donax, and bamboos. Susan also won best MSc presentation for her talk titled "Alien bamboos: A threat or opportunity?" at the Department of Botany and Zoology's Annual Meeting at SU.

2.2.3 Employment

The C·I·B puts considerable effort into tracking the progress of students and post-doctoral associates who leave our programmes. This information is not always comprehensive, however, and the table below supplies the information available at the time of writing this report. As requested by our Steering Committee, we aim to track students for the first five years.

Table 3. Where are they now?

Name	Level completed	Institution	Current position	Race	Gender
Alexander, Mhairi	Post-doctoral associate	SU	Lecturer, University of West Scotland, Glasgow	W	F
Ellender, Bruce	Post-doctoral associate	SAIAB	Pursuing independent research in Zambia	W	M
Faulkner, Katelyn	PhD	UKZN	Post-doctoral associate, University of Pretoria	W	F
Hill, Matthew	Post-doctoral associate	SU	Post-doctoral associate, CSIRO, Canberra, Australia	W	M
Mofu, Lubabalo			PhD candidate, Rhodes Univ. (C·I·B-supported)	B	M
Munyai, Caswell	PhD	UniVen	Lecturer, UKZN	B	M
Musedeli, Jufter	Masters	UniVen	Professional Development Programme, Agricultural Research Council	B	M
Poonan, Ulli	PhD	Wits	Director, Scimitar Social consultancy	B	F
Shackleton, Ross	PhD	SU	Consolidoc Fellowship, SU	W	M
Strydom, Matthys	PhD	SU	Academic Manager, African Academy of Environmental Leadership	W	M
Visser, Vernon	Post-doctoral associate	SU	Post-doctoral associate, University of Cape Town	W	M

2.2.4 Funding

Among the 86 students and post-doctoral associates, 30 students and eight post-doctoral associates were fully supported (bursary and project running costs), while 18 students and one post-doctoral associate received partial support (in the form of a partial or full bursary, running costs only, or 'in kind' support, e.g. supervision by a core team member). Independent funding was sourced by 19 students and eight post-doctoral associates, from other funding institutions, private foundations, and other (non-CoE) NRF instruments. These figures reflect the C·I·B's success in leveraging student funding from partner organisations, particularly through partnerships (e.g. SANBI's Invasive Species Programme), contracts (e.g. Natural Resources Management Programmes of the Dept. Environmental Affairs and CABI's Research for Development grant to Prof. Brian van Wilgen) and other NRF funding programmes (e.g. NRF funding for foreign post-graduate students).

2.2.5 Internships

The C·I·B continues to support interns from various organisations, including SANBI, NRF and DAFF. In particular, a DAFF collaboration with UKZN supports an undergraduate apprenticeship programme in biocontrol of invasive species. Ten to twelve undergraduate students are involved in research at PPRI (Cedara), Sugar Research (Mount Edgecombe) and at the University of KwaZulu-Natal, Pietermaritzburg during the January and June vacations.

2.2.6 Undergraduate training

The CIB offers a semester course in invasion science to 3rd year BSc students from the Faculties of Science and Agrisciences. During 2015, 60 students registered for the course, which means that a large number of students in Botany, Zoology, Entomology and Conservation are exposed to the basic principles of invasion ecology, management and policy-making.

3 Networking

3.1 Objectives

The C·I·B will continue to encourage a variety of approaches to scientific excellence, and to facilitate networking both among its members and with like-minded individuals and organizations in South Africa and abroad. In consequence, networking will continue to form a critical component of the C·I·B's work. The C·I·B's Fellowship programme will remain a key instrument for maintaining and developing partnerships, particularly in the international sphere.

3.2 Progress

3.2.1 Agreements with partner institutions

The C·I·B's partners are shown in Figure 21 below. No new national or international networking agreements were signed in 2015, but the existing partnerships were developed and strengthened through research and training collaborations.

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

3.2.2 Interaction with UCT Environmental Humanities

During 2015 the C·I·B initiated in-depth discussions with the coordinators of UCT's new MPhil in Environmental Humanities, Prof. Lesley Green and Prof. Lance van Sittert. We supported one MPhil student, Thomas Stielau (supervisors: Prof. Lance van Sittert and Dr John Measey), and hosted the entire MPhil class (11 students) for a full day of field-based interaction in the Jonkershoek Valley, on 15 May. The day was themed "And a river runs through it" and involved a day-long walk along the Eerste River, the main water supply for Stellenbosch which also crosses the eastern portion of the Cape Flats and exits into the sea near Strand. The walk began in Jonkershoek Nature Reserve (CapeNature) among fynbos vegetation with C·I·B core team members Dave Richardson, Brian van Wilgen, John Measey, John Wilson, Karen Esler and Mirijam Gaertner and visiting Fulbright fellow Prof. James Vonesh. From there, the group walked along the river through pine plantations, pasture and vineyards into the peri-urban areas around Stellenbosch and discussed the history of water management, plantation forestry and fire. The occasion gave unique opportunities for two academic groups from traditionally separate disciplines to discuss matters of mutual interest concerning invasion biology and will lead to stronger interactions between the two organisations in future (Figure 20).

Figure 20. UCT Environmental Humanities students and C·I·B researchers and students holding field-based discussions in Jonkershoek Nature Reserve. Photos: James Vonesh

3.2.3 Fellowship Programme

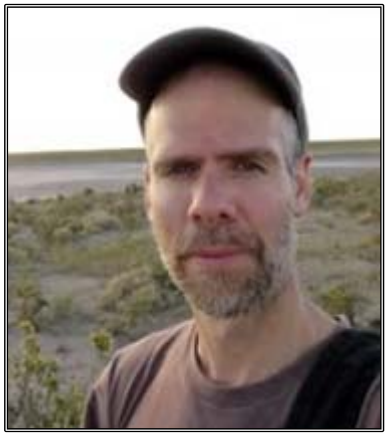
The C·I·B fellowship programme went from strength to strength in 2015. The Centre hosted four C·I·B Visiting Fellows from Canada, Australia and Brazil and a Fulbright Fellow form the USA.

Prof. James Vonesh (Commonwealth University of Virginia, USA) is a Fulbright Fellow hosted at the main C·I·B hub by Dr John Measey. Prof. Vonesh co-supervised Measey lab group students studying *Xenopus laevis* and the threatened Western Cape endemic *Xenopus gilli*. In addition Prof. Vonesh has given grant writing workshops for graduate students in the Department of Botany and Zoology and the C.I.B at SU and served on the 2015 national committee for the selection of South African students seeking Fulbright Fellowships to study and do research in the USA.

Prof. Vonesh also helped to co-coordinate the Functional Responses workshop led by Dr John Measey, and will be a contributor to several research outputs from this meeting. Prof. Vonesh and C.I.B. core team member Prof. Cang Hui collaborated on a theoretical study of the evolution of the timing of metamorphosis which they will present at international meetings in the USA and Europe in 2016. Prof. Vonesh is the lead PI on a US National Science Foundation collaborative research grant proposal to focus on the effect of large invasive fish predators on aquatic food web structure and linkages between aquatic and terrestrial agroecosystems in the Sundays River valley, a collaboration with Prof. Olaf Weyl's research group at SAIAB and Prof. Cang Hui (SU), Dr Michelle Jackson (UP), Dr Darragh Woodford (Wits) and recent C.I.B visiting fellow Dr Mike McCoy.

Prof. Paul Downey (Institute for Applied Ecology, University of Canberra, Australia) visited the C·I·B from April to July, and again in November. He was co-hosted by Dr Sabrina Kumschick (at the main hub at SU), and by Dr Llewellyn Foxcroft (SANParks, Kruger National Park). Downey's collaboration with Dr Sabrina Kumschick focused on risk assessment systems and approaches for alien species and how we can improve such systems globally by comparing risk assessment systems across invasive taxa and stages of the invasion. Prof. Downey is preparing a review on this subject. Secondly, Paul is working with Dr Llewellyn Foxcroft on examining how to improve management of alien species in Kruger National Park using an adaptive management system based on Thresholds of Potential Concern (TPCs), for which a series of alien species TPCs have been developed. Paul and Llewellyn will evaluate these TPCs and their management outcomes, with the aim of increasing management effectiveness for alien species in protected areas.

Prof. Jean Vitule (Universidade Federal do Paraná, Brazil) was hosted by Prof. Olaf Weyl in June and July, at SAIAB in Grahamstown. Prof.s Vitule and Weyl organized a workshop on the invasive catfish *Clarias gariepinus* in the Western Cape at CapeNature, Jonkershoek where Vitule also talked about catfish and other invasive fish species in Brazil. This workshop was attended by Drs Kumschick and Measey, CapeNature colleagues and others, and yielded a paper subsequently presented at the joint ESSA/ZSSA Conference in mid-July (see Vitule & Weyl. 2015. Understanding invasion status and risks of an emerging species in the global aquaculture industry – the African sharptooth catfish *Clarias gariepinus*). Profs Vitule and Weyl have also submitted a review paper to Journal of Fish Biology (now accepted) on *Clarias gariepinus* invasions in Brazil and South Africa.



Prof. Ben Evans (McMaster University, Canada) collaborated with Dr John Measey to explore the impact of interspecies hybridization on a threatened African clawed frog, *Xenopus gilli*. This frog is endemic to lowland coastal habitat in the Cape Flora Kingdom, and faces threats from a common and highly versatile species called the common platanna, *Xenopus laevis*. This project aims to better understand population structure within each of these species, and also how the extent of gene flow between them may have changed over the past two decades. Prof. Evans gave a seminar on sex chromosome evolution in amphibians, and a workshop on analysis of next generation sequence data (RADseq) at Stellenbosch University to provide a basic understanding of how it can be used to address research questions, and what bioinformatics tools are available to facilitate analysis. Prof. Evans co-supervises C·I·B-funded PhD student Ms Likho Sikutshwa.

Dr Mike McCoy (University of East Carolina, USA) was hosted by Dr John Measey at the main C·I·B hub, where he planned and participated in the Functional Responses workshop which will produce a manuscript on size-dependent functional response (in preparation). The Functional Responses workshop was attended by staff and students from across Stellenbosch University, as well as SAIAB and Rhodes University students of Prof. O. Weyl. Dr McCoy also participated in discussions on research in the Sundays River catchment, as well as leading lab group discussions. Profs Vonesh and Weyl and Drs McCoy and Measey prepared and submitted a National Science Foundation (USA) pre-proposal (January 2016).

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. Its main goals are to increase the understanding of science by learners at the secondary school level, to help develop their critical thinking skills, and to provide a means to stem the extinction of biodiversity experience. Further information brokerage will also take 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

Conservation in the Cape Floristic Region (national focus)

C·I·B researcher Prof. Brian van Wilgen, in collaboration with leading scientists from the Cape Floristic Region, hosted a colloquium on management challenges in the Cape Floristic Region on 13 April 2015 at the Lanzerac Hotel, Stellenbosch. The colloquium, co-hosted by the Royal Society of South Africa, marked the 70th anniversary of the publication in 1945 of C.L. Wicht's landmark paper on "The preservation of the vegetation of the South Western Cape", which appeared as a special publication of the Royal Society of South Africa. Among other things, Wicht's publication made proposals for protected areas, identified the threats posed by invasive alien plants, and it made the first serious suggestion that fire could be used to manage fynbos. Much progress has been made since then, and eight speakers made presentations about historic progress and future challenges. The colloquium was attended by 70 invited guests, representing a range of stakeholders from academia, management and government (Figure 21).

Figure 21. Participants in the colloquium on management challenges in the Cape Floristic Region held on 13 April 2015 in Stellenbosch. Photo: Wiida Basson.

The main outcome of this colloquium will be a monograph that is to be published in the *Transactions of the Royal Society of South Africa*. The monograph, entitled "Ecological research and conservation management in the Cape Floristic Region between 1945 and 2015: History, current understanding and future challenges", is the result of a collaboration between 15 authors from 14 institutions, and will be published during 2016. It constitutes a unique blend of history, science and applied management, and will provide an exceptional wealth of information for scholars and managers in future.

6th International Symposium-Workshop on Frugivores & Seed Dispersal

Core team member Prof. Colleen Downs (SARChI Chair in South African Research Chair in Ecosystem Health and Biodiversity in KZN and the Eastern Cape) coordinated the 6th International Symposium-Workshop on Frugivores & Seed Dispersal at Alpine Heath in the Drakensberg in June 2015, co-funded by the C·I·B. The theme for the conference was "Searching for commonality in frugivory and seed dispersal: merging community ecological dynamics with phylogeny across different biomes." This was a multi- and interdisciplinary conference where aspects of frugivores and their seed dispersal mechanisms were discussed. At the conference, researchers from around the world presented their work on focal topics on frugivores and seed dispersal, including invasive species. In total, 28 countries were represented at the conference by researchers who presented their work, either via a poster or a talk. The conference also gave students the chance to make presentations and several of our MSc and PhD students and post-doctoral associates presented talks and posters.

Evolutionary dynamics of tree invasions: drivers, dimensions, and implications for management

C·I·B post-doctoral associate Dr Heidi Hirsch, in collaboration with core team members Jaco Le Roux (Dept. Botany and Zoology, SU) and Dave Richardson, organized an international workshop entitled "Evolutionary dynamics of tree invasions: drivers, dimensions, and implications for management" which was held on 9 and 10 November 2015 at the Lanzerac Hotel, Stellenbosch. A diverse team of 25 scientists from South Africa and nine other countries came together to synthesize current knowledge on the key processes which underlie evolutionary processes associated with tree introductions and invasions, to seek improved understanding of the dimensions of these processes across different scales, and to explore their consequences for management.

The main outcome of this workshop will be a special issue of the international journal *AoB Plants* (impact factor = 2.3) comprising most of the papers presented at the workshop, as well as several new contributions that emerged from the discussions at the workshop. This special issue will also lead to multidisciplinary research contributions and collaborations between various South African and foreign institutes. A major benefit of such an approach is the establishment of international links that will lead to further collaborative research in the future.

Functional responses as a tool in invasion ecology (international focus)

C·I·B post-doctoral associate Dr Mhairi Alexander, in collaboration with core team member Dr John Measey (SU), C·I·B Visiting Fellow Dr Mike McCoy and visiting Fulbright fellow Prof. James Vonesh, organized an international workshop which was held on 9 and 10 November 2015 at Stellenbosch

University. The workshop hosted 25 scientists from 11 institutions in South Africa and overseas to discuss how functional responses have been used as a tool in invasion ecology, and how this approach can to be developed into a best-practice model for the future. Three outputs from the meeting are expected in 2016: a Flashpoint Perspective article in *Biological Invasions*, with counterpoint and response. This will provide different viewpoints on the use of functional responses in invasion biology, as well as caveats that should be taken into account. Another paper (also intended for *Biological Invasions*) will cover the empirical analyses of functional responses, resulting in a suggestion for best-practice analysis of functional response data. Lastly, a database of functional response experiments will be compiled and published, to be used for future studies. The workshop provided an opportunity for a range of South African and international researchers, post-doctoral associates and students to generate long-term ties with the C·I·B in relation to functional responses, and for C·I·B delegates to be aware of ongoing complementary work across the Centre.

Southern African Amphibian Red List Workshop (international focus)

C·I·B core team member Dr John Measey is the IUCN's regional chair of amphibians and as such is responsible for convening a workshop of African amphibian experts every five years to re-assess the conservation status of the region's amphibians. The southern African region (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe) has 239 amphibian species, of which 38 carry an IUCN threatened status (Vulnerable, Endangered or Critically Endangered), and a further 32 are considered Data Deficient. The entire region was last assessed in 2004, while South Africa, Lesotho and Swaziland were assessed during a workshop in 2009 (see Measey 2011; *SANBI Biodiversity Series* **19**; 84pp). The workshop conducted from 4 to 6 November 2015 had 16 representatives from Angola, Malawi, South Africa, and Zimbabwe, whose combined expertise on amphibians is considered to cover the entire region. Over three days, the participants considered each of the 70 species from the southern African region that were not of Least Concern, together with any newly described species or species that had been taxonomically updated. This was the first IUCN Red Listing experience for partners from Angola, Malawi and Zimbabwe who gained important training and insights into the Red Listing process.

Participants were able to bring attention to regions under particular threat, as well as species that have not been seen for many decades. In addition to the formal Red Listing procedure, the workshop made time to examine the results of priorities that were made for amphibian research at the 2009 meeting. Given the low capacity and funding for threatened amphibian species, prioritising amphibian research was seen as a successful initiative for South Africa, with the suggestion that this should be extended to the entire southern African region. Participants began to put together new priorities for the next five years that will go together with the next Red List assessment for the region in 2020.

Invasive *Xenopus* (INVAXEN) workshop (international focus)

Held simultaneously in both Portugal and South Africa, via a teleconferencing link, the INVAXEN workshop brought together 22 researchers from Europe, North America and South Africa (including six C·I·B post-graduate students) conducting research on the invasive frog, *Xenopus laevis*. Delegates discussed issues as diverse as demography, physiology, genetics and ecology of *X. laevis* in both its

native and introduced ranges. C·I·B Visiting Fellow Prof. Ben Evans (McMaster University) gave a talk on his ongoing work with C·I·B core team member Dr John Measey on genetic introgression between *X. laevis* and the Cape endemic *X. gilli* in South Africa.

A reduced representation approach to population genetic analyses and applications in evolution

Next generation sequencing is set to revolutionise the way in which we approach many fields of genetics, including population genetics. Core team member, Dr John Measey and visiting C·I·B fellow and faculty at McMaster University, Prof. Ben Evans, recently presented a hands-on workshop in June 2015 for those wishing to gain a basic understanding of reduced representation genome sequencing, how it can be used to address research questions, and what relevant bioinformatics tools are available to facilitate analysis. The workshop was split into a morning which gave an introduction to reduced representation genome sequencing (e.g. RADseq, GBS), exploring examples from Ben's research that utilize this datatype. The afternoon session was interactive, including (a) basic Unix use, including file manipulation and text editing with Emacs, (b) quality scores, file types, and de-multiplexing of multiplexed samples, (c) aligning reduced representation data to a reference genome, (a) assembling reduced representation data without a reference genome, (d) genotype calling, and (e) applications to phylogenomics, population genomics, and linkage analysis.

The workshop was attended by 22 people from across several faculties at Stellenbosch University. Ben's down-to-earth presentation of complex data manipulation issues provided us with an exceptionally clear insight into reduced representation genome sequencing. There are a host of ways in which such data can be used to study the nature of invasive populations.

Annual research meeting (national focus)

The 2015 ARM was attended by 125 people, composed of post-graduate students, post-doctoral associates, core team members, staff, guests and Steering Committee members of the Centre (Figure 22). Guest speakers included Prof. Laura Meyerson (University of Rhode Island, USA) who was appointed to the C·I·B Steering Committee in 2015 as one of two science advisors. Prof. Meyerson presented a fascinating talk about the role of the common reed, *Phragmites australis*, as a model species for the study of plant invasions. Prof. Tony Ricciardi from the Redpath Museum, McGill University, Canada, presented a keynote address titled *"The future of invasion science*" in which he gave an incisive overview over the field of invasion science and proposed an agenda for a vibrant future research programme that includes exploring the generality of concepts, creating coherent theory for understanding impacts, embracing context dependence, integrating more evolutionary biology, using large-scale coordinated approaches and exploring linkages with other fields.

Forty two Masters and PhD students participated by presenting a talk and an infographic designed to communicate their work to a lay audience. The student sessions were each coordinated by a post-doctoral associate leader, who guided the students in designing their presentations and integrated the subject matter of the talks with their own work. Nine post-doctoral associates of the Centre participated in this way.

For the first time, we asked students to prepare an infographic that could be used to communicate their science to a non-scientific audience. The students did a superb job of producing punchy, interesting illustrations of the nature and importance of their work. The C·I·B's international science advisors commented: "Many of the infographics were superb while others afforded the opportunity for students to evaluate their skills in communicating their research in a broad forum. This was a modern and forward-looking approach to all important science communication that allowed all students to participate and gain experience."

Figure 22. Staff, guests and team members at the 2015 Annual Research Meeting held in the Department of Botany and Zoolgy, Stellenbosch University.

The range of topics addressed by the student and post-doctoral associate sessions at the 2015 Annual Research Meeting included:

- Pod 1 - Looking at alien species from a human perspective, Chair: Ana Novoa
- Pod 2 - Learn before we leap: how much do we need to know to manage invasive species? Chair: Jeremy Shelton
- Pod 3 -Invasions, functional traits and niche dimension interactions, Chair: Ryan Wasserman
- Pod 4 - Spatial dynamics of ecological communities from local to continental scales, Chair: Heidi Hirsch
- Pod 5 – Drivers and management of biological invasions, Chair: Raquel Garcia
- Pod 6 - A toolbox for the 21st century invasion biologist, Chair: Matt Hill
- Pod 7 – Urban invaders - Where they are and where they might go, Chair: Palesa Mothapo

The winning pod was coordinated by Dr Ana Novoa (SU) and addressed a range of invasion issues from the role of rats in urban ecosystems to the costs and benefits of earthworm introductions.

"Looking at alien species from a human perspective":

Rats: worming their way through the city	Rolanda Julius, PhD candidate, UP
Invasive alien plants on private land in the Cape Floristic Region	Jacques van Rensburg, MSc candidate, SU
Costs and benefits of earthworms in South Africa	Siviwe Lamani, PhD candidate, SU
Alien bamboos: A threat or opportunity?	Susan Canavan, PhD candidate (upgr.), SU
Historical expansion of the African Clawed Frog, Xenopus laevis	Thomas Steilau, MA candidate, UCT

4.2.2 Web-based services

Information Retrieval and Submission System

The C·I·B's Information Retrieval and Submission System (IRSS) contains a total of 1896 items, an increase of 21% on 2014 figures. The material archived includes. The database is growing but requires much further input from team members to become a comprehensive library of Centre outputs.

Web page

The C·I·B web page (URL: http://academic.sun.ac.za/cib/) had 20699 unique visitors (17% increase). These visits are made up of:

- SA: 2 881 (14%)
- USA: 11 842 (57%)
- UK: 2 548 (12%)
- Spain: 630 (3%)
- Germany: 468 (2%)
- Other: 12%

There were 39 512 unique page views, with an average visit duration of 2 m 48 s. our pages are found through search engines (50%), direct link (37%), from other sites (13%).

Social media

The C·I·B has maintained a Facebook presence since July 2013 (URL: https://www.facebook.com/centreforinvasionbiology). We have 371 likes (followers) in total. More than ninety posts were submitted in 2015, with an average reach per post (i.e. number of people who view each post) of 377. Visitors to our Facebook page are 52% female; 46% male. Most visitors are between the ages of 25 and 34.

Iimobvane also maintains its own Facebook page C*reated on 31 October 2015 (*URL: https://www.facebook.com/IimbovaneOutreachProject). To date Iimbovane has 135 followers (63% women and 35% men) and has reached 1418 viewers. Most followers are between 18 and 24 years old (second most common age group is 13 – 17 years). The age groups fit into the age group

targeted by the programme (senior high school learners and young adults) and indicates that the Facebook page is reaching the right target market.

Late in 2014, the C·I·B became active on Twitter in 2014. Our Twitter handle, @InvasionScience (URL: https://twitter.com/invasionscience), now has 134 followers, has tweeted 386 times and has distributed 72 videos and photos. The profile of our Twitter followers include senior academics around the world, media officers of similar institutes in other countries, former Science Advisors, alumni and current students and post-doctoral associates of the Centre. All vignettes sent to the NRF are also distributed on Twitter.

4.2.3 Iimbovane Outreach Project

In 2015, the Iimbovane Outreach Project visited its partnership schools with a new initiative called "Ants up close". The initiative involved the use of mini-microscopes to investigate morphological differences in ant species. The "Ants up close" initiative was a hit with both learners and educators. After presenting to the class the basics of taxonomy, ant morphology and how it is used to distinguish between different species, the learners then had to use his/her own microscope to discover the name of his/her ant. In doing so, the learners could see how ant species differ from each other based on their "looks", thereby developing their understanding of biodiversity. This initiative also taught the learners basic skills associated with microscopy, for example: how to use the focus function of a microscope, how to handle a specimen under a microscope, how to identify different parts of an ant's body and how to use a scientific identification key.

During the October school holiday, the Iimbovane Outreach Project hosted a workshop for 30 learners (38% males and 62% females) from 13 partnerships schools. The workshop titled "Antastic" was held from 5 to 9 October 2015 on the Stellenbosch University campus. The workshop met with the goal of teaching learners about biodiversity in Fynbos ecosystems (both terrestrial and freshwater), biodiversity as indicators of environmental health, biodiversity loss and invasive species. Training was done through interaction activities whereby learners were involved monitoring, sampling, and data collection and analysis (Figure 22). This allowed the learners to apply the scientific method to the activities, on which they reported back through a PowerPoint presentation.

The Iimbovane Outreach Project hosted a further one-day "Biodiversity Explorer" workshop (16 October 2015) for a group of Grade 10 Life Science learners from the Umyezo Wama Apile Combined School, in Grabouw. Due to the school's proximity to the Stellenbosch University campus, the project team invited the whole Life Science class for a unique university experience instead of visiting the school grounds. The morning session took the learners to a nearby nature reserve, the Jan Marais Nature Reserve, where they learned about the scientific method, biodiversity monitoring and sampling techniques. The afternoon session focused on microscope work, insect identifications and morphology. The workshop benefitted the learners by taking them for one day away from their usual classroom and by showing them how scientists work in an academic setting. The workshop was attended by 23 learners of whom 12 were male and 11 female (Figure 23).

Feedback from learners who attended Iimbovane's Biodiversity Explorer workshop (16 October 2015)

"*New skills such as team work were the most important skill at this workshop*."

Learner from Gerrit du Plessis Secondary School, Riversdal

"*Hoe om insekte en miere te versamel, asook onder watter tipe groep dit geklassifiseer word.*"

Learner from Riviersonderend High School, Riviersonderend

"*It was my first time I come to the university lab in fact any lab and use microscope*."

Learner from Umyezo Wama Apile Combined School, Grabouw

In 2015, the Iimbovane Outreach Project once again joined other conservation institutions to showcase career options in the biological sciences at the Western Cape Education Department's (WCED) Careers Expo. Iimbovane played an important role in giving the learners guidance on subject choices and tertiary institution entry requirements.

In 2015, the Iimbovane Outreach Project featured in the *Quest: Science for South Africa* magazine. This popular science magazine is published quarterly and aimed at a target audience comprising of learners, educators and the general public. The *Quest* publication further featured a profile on Leonne Adams, currently a third year BSc student at Stellenbosch University student, who has been involved with Iimbovane since her Grade 10 school year in 2010.

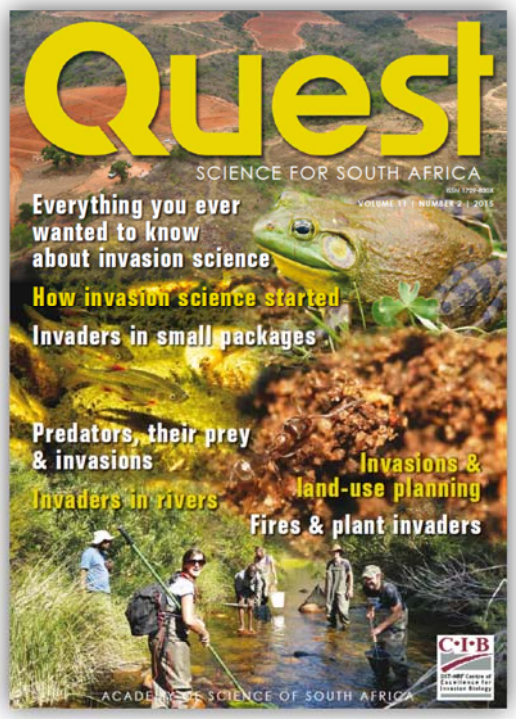
Figure 23. Clockwise from upper left: A learner from the Riversdal investigating an ant during the "Ants up close" initiative (Photo: Dorette du Plessis). Learners from Grabouw sampling invertebrates during the "Biodiversity explorer" workshop in Stellenbosch (Photo: Dorette du Plessis). Grade 10 Life Science class of Umyezo Wama Apile (Grabouw) during the "Biodiversity explorer" workshop (Photo: Sophia Turner).

In November 2015, the Iimbovane Outreach Project appointed a new staff member. Ms Londiwe Msomi, took on the role of Education Outreach Officer for the project in November 2015. Londiwe's expertise lies in the fields of environmental education and educator training. She has been the past six years an Environmental Education Practitioner with the Wildlife and Environmental Society of South Africa (WESSA) in Howick.

4.2.4 Media highlights

In 2015, 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 section (Appendix A.4) of the report; however, there are a few highlights that deserve special mention.

In May 2015, the C·I·B team collaborated with the popular science magazine *Quest* to produce a special issue dedicated to biological invasions in South Africa. The magazine included articles about issues that are being addressed by research groups at the C·I·B, ranging from plants to insects and marine organisms. Apart from giving information on these problem species, the articles highlighted career profiles of invasion scientists working in academic and non-academic organisations. Post-graduate students and Iimbovane learners were also interviewed about their interest in invasion science (see Figure 23 below).



Iimbovane learner begins her future in science

Leonne Adams was introduced to invasion science during a visit to her school by the Iimbovane Outreach Project. This sparked Leonne's interest in science, so much so, that she enrolled for a degree in biological sciences. *Quest* asked her a few questions about her studies.

Where did you go to school?
Gerrit du Plessis Secondary School, Riversdale.

What are you studying?
I am doing a Bachelor of Science in Biological Sciences (Human Life Sciences) at Stellenbosch University.

Tell us about your interest in science
My interests lie in nature and in the body, particularly human tissues. I would like to go into forensics. My first experience of real science was during our schools involvement with the Iimbovane Outreach Project. The project showed me as a Grade 10 learner what science is about, from working outside in the field, doing laboratory work and microscope work and how to explain one's findings. The Iimbovane Outreach Project played a part in my choice for tertiary studies. I always knew that I wanted to study further after school, but I was not familiar with the different courses offered. Being based at Stellenbosch University during one of the Iimbovane Outreach Project workshops, I was exposed to the university and what it offers. It made me feel self-assured about coming to Stellenbosch University.

Do you have any advice for school learners that are considering a career in science?
If you want something enough, you will get it. Show interest, go the extra mile and grab every opportunity, so that you can make an informed decision. Talk to people in the field, read up on different research fields and participate in volunteer work.

Quest 11|2 2015 | 13

Figure 23. Leonne Adams, a former Iimbovane learner, has started a Bachelor of Science degree at Stellenbosch University. Leonne featured in the special issue of *Quest* devoted to biological invasions research.

A paper by C·I·B Core Team Member John Measey and his herpetology research group received wide media attention. The paper, published in the journal *PeerJ*, presented a review of the available scientific literature on frog diets from all over the world. The group found that it is not uncommon for a frog to eat another frog. The paper has led to several articles in the media and featured in *Die Burger*, and on online news sites including *New Scientist* and *Live Science*. The research was further publicised through an interview with Dr John Measey on *Radio Sonder Grense FM*.

C·I·B Core Team Member and fire ecologist, Prof. Brian van Wilgen, received much media attention following large-scale wildfires in Cape Town, in March 2015. Van Wilgen's response to fire management and its prevention featured on several online news platforms including *Bizcommunity*, *SciDevNet* and *Cape Times*. The importance of fire in the Fynbos biome and fire control received further exposure through radio interviews with Prof. Brian van Wilgen on *Channel Africa*, *Matie FM* and *WitsRadio*.

In September 2015, a paper by C·I·B Associate, Petr Pyšek and colleagues in the journal *Nature* drew much attention from both national and international media. The research, which found that 13,168 plants (3.9% of the total plants worldwide) have become naturalised elsewhere as a result of human activity, featured in articles on news sites including *The Guardian*, *Der Tagesspiegel*, *Reuters*, *The Japan Times*, *News 24*, *SABC news*, *International Business Times*, *Deutsche Welle*, *Times Live*, *ABS Science* and *Nature Middle East*.

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 the Department of Environmental Affairs (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.

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

6 Gender impact of the Centre's work

The gender-specific impacts of the Centre's research are difficult to quantify, because the research is not by design gender-specific. However, it almost certainly has some gender-based impacts. For example, an extensive portfolio of the research is conducted through our collaborative research in

support of the management of invasive plant species in South Africa, to inform the operations of the Natural Resource Management Programmes (formerly Working for Water). The majority of people employed to work on NRM projects are women, and so any changes to the efficiency of these programmes may have a beneficial effect on the employees. In addition, in subsistence livelihoods, women bear the most responsibility for agriculture, water provision and household management (Seleti and Tlhompho 2014; *J. Hum. Ecol.* 48: 33-41). Therefore, invasive species heavily affect women, their health and their burden of work in these contexts. Public engagement and application of invasion science is crucial to bring research results into policy and practice, and this forms the focus of greater effort in the current phase of the Centre's development.

The C·I·B gives careful attention to the representation of women in all facets of its work. Although women only represent 31% of the core team (8 out of 26), women are much better represented among the C·I·B staff (83%; 15 out of 18), post-doctoral associates (56%; 9 out of 16) and students (52%; 36 out of 68). The Iimbovane project is staffed entirely by women, providing a powerful role model and informal career path guidance for aspiring scientists. Iimbovane is increasingly being drawn into hosting learners who wish to do vacation work in the Iimbovane labs, and it is almost invariably young women who volunteer in this way.

7 Governance and organisational structure

7.1 Steering Committee

The C·I·B is advised by a Steering Committee, as stipulated in the 2014 Memorandum of Agreement between the National Research Foundation and Stellenbosch University. The Steering Committee meets twice each year and advises on and approves annual plans and budgets, as well as key reports such as this Annual Report. The committee also provides crucial links with key organisations in the biological field and with funding bodies, as well as providing expertise in certain research areas that may be under-represented in other Centre structures.

Table 4. The Steering Committee of the C·I·B in 2015

Name	Affiliation	Role
Prof. Eugene Cloete	Vice-Rector, Research, Innovation and Postgraduate Students, Stellenbosch University	Chair of the Board; *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 Thandi Mgwebi	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

Name	Affiliation	Role
Prof. John Donaldson	Director, Applied Biodiversity Research Division, SANBI	Industry representative
Prof. Paul Skelton	Emeritus Professor, SAIAB & 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 rep.*
Prof. Stefan Foord	Associate Professor, Department of Zoology, University of Venda	Core team rep.*
Dr Sarah Davies	Deputy Director, C·I·B, Stellenbosch University	Ex officio member, staff rep.

* The core team representative changed during 2015, with Prof. Foord serving for the first half of the year and Prof. Somers from October onwards.

7.2 Core team members

Core team members are researchers located in a range of South African institutions, including universities, national regulators and municipalities. Core team members conduct research, train students and undertake outreach in biological invasions towards the goals of the CoE.

Table 5. C·I·B Core Team members in 2015

Name	Nationality	Institution	Race	Gender	% Time spent working in CoE
Prof. David Richardson	SA	SU	W	M	100
Dr Sarah Davies	SA	SU	W	F	100
Prof. Marcus Byrne	SA	Wits	W	M	5
Prof. Chris Chimimba	SA	UP	B	M	10
Dr Susana Clusella-Trullas	Spain (SA resident)	SU	W	F	70
Prof. Colleen Downs	SA	UKZN	W	F	8
Prof. Karen Esler	SA	SU	W	F	10
Prof. Stefan Foord	SA	UniVen	W	M	20
Dr Llewellyn Foxcroft	SA	SANParks	W	M	20
Dr Mirijam Gaertner	Germany (SA resident)	CoCT	W	F	95
Prof. Charles Griffiths	SA	UCT	W	M	20
Prof. Cang Hui	China (SA resident)	SU	B	M	20
Prof. Steven Johnson	SA	UKZN	W	M	5
Dr Sabrina Kumschick	Switzerland	SU	W	F	95
Prof. Jaco Le Roux	SA	SU	W	M	50
Dr John Measey	UK	SU	W	M	100
Prof. Mark Robertson	SA	UP	W	M	20
Dr Tammy Robinson	SA	SU	W	F	50
Prof. Mathieu Rouget	France (SA resident)	UKZN	W	M	10
Prof. Michael Somers	SA	UP	W	M	10
Prof. Peter Taylor	SA	UniVen	W	M	10
Prof. John Terblanche	SA	SU	W	M	10
Prof. Brian van Wilgen	SA	SU	W	M	100
Prof. Olaf Weyl	SA	SAIAB	W	M	10
Prof. John Wilson	SA	SANBI	W	M	100
Prof. Theresa Wossler	SA	SU	W	F	10

7.3 Research associates

The C·I·B's research associates are individuals working within academic and non-academic organisations who are expert in or interested in matters related to biological invasions. The research associate network allows the Centre to extend its reach and 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 6. C·I·B Research Associates in 2015

Full Name	Affiliation
Prof. Tim Blackburn	Professor of Invasion Biology, Centre for Biodiversity & Environment Research, Department of Genetics, Evolution & Environment, University College London, United Kingdom
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, South Africa
Prof. Jan Gilliomee	Research Associate, Dept Botany and Zoology, Stellenbosch Unviersity, South Africa
Dr Patricia Holmes	Biodiversity Management Branch, Environmental Resource Management, City of Cape Town, South Africa
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, 3800, Australia
Dr Jesse Kalwij	Senior Researcher, Institute for Ecosystem Research - Geobotany, Kiel University, Kiel, 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, South Africa
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, South Africa
Dr Nicola van Wilgen	Global Change Scientist, Cape Research Centre, South African National Parks, South Africa
Dr Darragh Woodford	Lecturer, Department of Animal Plant and Environmental Sciences, Wits University, South Africa

7.4 Administrative staff

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

Name	Institution	Position	Race	Gender
Dr Sarah Davies	SU	Deputy Director	W	F
Ms Karla Coombe-Davis	SU	Database Manager	W	F
Ms Josephine De Mink[#]	SU	Wiley-Blackwell Editorial Assistant	B	F
Ms Dorette Du Plessis	SU	Chief Technical Officer: Outreach	W	F
Ms Chantal Ferriera	UP	Technical Officer & Admin. Assistant	W	F
Ms Anel Garthwaite*	SU	PA to Director	W	F
Ms Megan Koordom	SU	Molecular Lab. Technical Assistant	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

[#] Contract position from Wiley-Blackwell closed December 2015

* Resigned September 2015

**Joined November 2015

8 Stage progress

This CoE is currently in **Stage 6**.

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

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

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

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

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)

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

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

2015: Statement of compliance for 2015 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

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

2015: Women students 54% of student group

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

2015: Black students 52% 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)

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

2015: 2.25 years

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

2015: 4.4 years

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

stage

2015: 4.4 years

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

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

Number of patents ≥ 1

2015: 0

Number of peer reviewed publications ≥ 60 on average per annum

2015: 178

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

2015: 2

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

2015: 33

Number of national conference presentations ≥ 20 on average per annum

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

Number of international conference presentation ≥ 10 on average per annum

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

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

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

Number of local conferences organized ≥ 1 at end of stage

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

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)

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.

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).

9 Conclusion

2015 was another very successful year for the C·I·B as gauged by achievements under all of our Key Performance Areas. The Centre is clearly firing on all cylinders and is firmly established nationally and internationally as a Centre of Excellence. Thanks are due to our funders, staff, students, partners and all who work with us.

10 Audited financial statements

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS - 31 DECEMBER 2015

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2015

CONTENTS **Page**

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

.....

.....2016
DATE

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF FINANCIAL POSITION AT 31 DECEMBER 2015

	Notes	2015	2014
		R	R
ASSETS			
NON-CURRENT ASSETS		598 631.25	671 386.76
Equipment and vehicles	2	598 631.25	671 386.76
CURRENT ASSETS		8 935 033.94	7 227 789.52
Trade and other receivables	3	191 930.15	9 435.76
Stellenbosch University	4	8 743 103.79	7 218 353.76
TOTAL ASSETS		**9 533 665.19**	**7 899 176.28**
EQUITY AND LIABILITIES			
CAPITAL AND RESERVES		9 341 721.20	7 548 744.98
Accumulated funds		9 341 721.20	7 548 744.98
CURRENT LIABILITIES		191 943.99	350 431.30
Trade and other payables	5	191 943.99	350 431.30
TOTAL FUNDS AND LIABILITIES		**9 533 665.19**	**7 899 176.28**

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER 2015

	Notes	2015	2014
		R	R
Revenue		9 373 273.00	8 926 926.00
Other income		3 691 606.32	3 087 420.37
Operating expenses	7	(11 901 809.61)	(11 944 010.03)
Operating surplus		1 163 069.71	70 336.34
Finance income		629 906.51	524 603.94
Finance cost		-	(4 548.99)
Surplus for the year		1 792 976.22	590 391.29
Other comprehensive income		-	-
Total comprehensive income for the year		1 792 976.22	590 391.29

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 DECEMBER 2015

	2015	2014
	R	R
ACCUMULATED FUNDS		
At the beginning of the year	7 548 744.98	6 958 353.69
Total comprehensive income for the year	1 792 976.22	590 391.29
At the end of the year	**9 341 721.20**	**7 548 744.98**

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 31 DECEMBER 2015

	2015	2014
	R	R
CASH FLOWS FROM OPERATING ACTIVITIES		
Net surplus for the year	1 792 976.22	590 391.29
Adjustment for:		
Interest received	(629 906.51)	(524 603.94)
Interest paid	-	4 548.99
Exchange rate loss	135.33	2 855.77
Depreciation	283 017.41	305 002.25
Profit on sale of equipment and vehicles	-	(7 456.14)
Operating surplus before working capital adjustments	1 446 222.45	370 738.22
Working capital adjustments	(341 117.03)	(81 320.54)
(Increase)/Decrease in trade and other receivables	(182 494.39)	(7 136.11)
(Decrease)/Increase in trade and other payables	(158 622.64)	(74 184.43)
Cash generated from operations	1 105 105.43	289 417.68
Interest received	629 906.51	524 603.94
Interest paid	-	(4 548.99)
NET CASH FLOWS FROM OPERATING ACTIVITIES	1 735 011.94	809 472.63
CASH FLOWS FROM INVESTMENT ACTIVITIES		
Equipment and vehicles purchased	(211 696.91)	(179 366.56)
Proceeds on the sale of fixed assets	1 435.01	7 456.14
Increase in amount owed by Stellenbosch University	(1 524 750.03)	(637 562.21)
NET CASH FLOWS FROM INVESTMENT ACTIVITIES	(1 735 011.93)	(809 472.63)
NET INCREASE IN CASH AND CASH EQUIVALENTS	0.01	-
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	-	-
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	0.01	-

DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY

NOTES TO THE ANNUAL FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2015

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 Centres 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 C·I·B conducts research and student training through a distributed network of researchers at several 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 South African National Biodiversity Institute (SANBI).

The DST-NRF Centre of Excellence for Invasion Biology ("CIB") carve-out Financial Statements, prepared in connection with the Arrangement, present the historical carve-out financial position, results of operations, changes in net investment and cash flows of CIB. The CIB carveout Financial Statements have been derived from the accounting records of Stellenbosch University on a carve-out basis 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 2015. The CIB carve-out Consolidated Financial Statements have been prepared on a carve-out basis and the results 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.

1. ACCOUNTING POLICY (continued)

INCOME RECOGNITION

Income consists mainly of a National Research Foundation grant, the contribution from Stellenbosch University 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.

EMPLOYEE BENEFITS

Post-retirement medical benefits, pension liabilities and long-service benefits are not accounted for in these financial statements and are recognised and provided in the financial statements of the Stellenbosch University.

STANDARDS, INTERPRETATIONS AND AMENDMENTS NOT YET EFFECTIVE

The following standards and amendments to existing standards have been published and are mandatory for the centre's accounting periods beginning on or after 1 January 2016 or later periods, but which the centre has not early adopted.
Management is of the opinion that these amendments will not have a material effect on the financial statements.

Amendments to IFRS 10, 'Consolidated financial statements' and IAS 28,'Investments in associates and joint ventures' on sale or contribution of assets (1 January 2016)
Amendments to IFRS 10, 'Consolidated financial statements' and IAS 28,'Investments in associates and joint ventures' on applying the consolidation exemption (1 January 2016)
Amendment 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)
Amendment 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 IAS 27, 'Separate financial statements' on equity accounting (1 January 2016)
IFRS 15 – Revenue from contracts with customers (1 January 2018)
IFRS 9 – Financial Instruments (2009 &2010) (1 January 2018)
Amendment to IFRS 9 -'Financial instruments', on general hedge accounting (1 January 2018)
IFRS 16 – Leases (1 January 2019)

The International Accounting Standards Board (IASB) drives an annual improvements project in which necessary amendments that are not urgent can be made to published standards. Each of these have been assessed and will not have a material impact on the financial statements.

CRITICAL ACCOUNTING ESTIMATES AND JUDGEMENTS

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

Useful lives of assets

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

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

2. EQUIPMENT AND VEHICLES

	Equipment R	Vehicles R	TOTAL R
31 December 2015			
Carrying amount 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)
31 December 2014			
Carrying amount at the beginning of the year	410 516.72	386 505.73	797 022.45
Cost	3 019 378.45	494 105.01	3 513 483.46
Accumulated depreciation	(2 608 861.73)	(107 599.28)	(2 716 461.01)
Additions during the year	179 366.58	-	179 366.58
Transfers	-	-	-
Cost	10 376.98	-	10 376.98
Accumulated depreciation	(10 376.98)	-	(10 376.98)
Disposals	-	-	-
Cost	(40 334.91)	-	(40 334.91)
Accumulated depreciation	40 334.91	-	40 334.91
Depreciation for the year	(258 108.21)	(46 894.04)	(305 002.25)
Carrying amount at the end 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)

3. TRADE AND OTHER RECEIVABLES

	2015 R	2014 R
Trade receivables	189 630.50	7 136.11
Other	2 299.65	2 299.65
	191 930.15	9 435.76
The ageing of these receivables are as follows:		
Up to 2 months	191 930.15	9 435.76
2 to 6 months	-	-
	191 930.15	9 435.76

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 2015 was 5.80% (2014: 5.90%). The loan has no fixed terms of repayment.

	2015 R	2014 R
5. TRADE AND OTHER PAYABLES		
Leave pay provision	105 789.67	111 544.17
Other creditors	19 961.12	751.16
Income received in advance	-	126 460.00
Provision for audit fees	66 193.20	111 675.97
	191 943.99	350 431.30

6. INCOME TAX

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

7. OPERATING EXPENSES

Operating expenses includes the following disclosable amounts:

Audit fees - audit	66 191.64	59 948.47
Depreciation	283 017.41	305 002.25
Foreign exchange loss	1 019.46	2 855.77
Salaries	5 074 277.75	4 367 107.62
Team member research cost	5 301 363.66	6 088 571.41
Other	1 175 939.69	1 120 524.51
	11 901 809.61	11 944 010.03

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 2015 and 2014, if the interest rate had been 100 basis points higher/lower and all other variables held constant, the centre's surplus/(shortfall) would have increased/decreased as a result of interest received on loans by R87 431.04 (2014: R72 183.54). The other financial instruments are not exposed to interest rate risk.

8. FINANCIAL INSTRUMENTS (continued)

Fair values

At 31 December 2015 and 2014 the carrying amounts of receivables, loans and payables approximated their fair values due to the short-term maturities of these assets and liabilities.

	Carrying value	Contractual cash flows	< 1 year	1 - 5 years	> 5 years
	R	R	R	R	R
Financial liabilities					
31 December 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	-	-
31 December 2014					
Trade and other payables	350 431.30	350 431.30	350 431.30	-	-
Net financial liabilities	350 431.30	350 431.30	350 431.30	-	-

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 2015

	2015 R	2014 R
INCOME	13 694 785.83	12 538 950.31
National Research Foundation grant	9 373 273.00	8 926 926.00
Other income	2 753 395.19	2 187 271.23
SU contribution	937 327.00	892 693.00
Interest received	629 906.51	524 603.94
Foreign exchange profit	884.13	-
Profit on sale of equipment and vehicles	-	7 456.14
EXPENDITURE	11 901 809.61	11 948 559.02
Operational expenses	6 827 531.86	7 581 451.40
Advertisements	18 473.83	24 670.31
Audit fees - current year	66 193.20	54 675.97
- previous year (over)/under provision	(1.57)	5 272.50
Clothing	2 055.00	
Consumables	13 359.34	40 683.19
Copying and stationery	35 550.13	38 722.77
Depreciation	283 017.41	305 002.25
Entertainment	5 347.20	8 733.99
Foreign exchange loss	1 019.46	2 855.77
Interest paid	-	4 548.99
Insurance	497.64	4 965.73
Indirect cost recovery	-	141 820.67
Levies	104 901.49	-
Membership and affiliation fees	21 209.50	20 510.00
Non-capitalised books	245.96	-
Small capital works: not capitalised	36 541.26	52 142.41
Postage, telephone and fax	80 198.61	106 736.80
Safety clothing	-	1 294.43
Rent paid for facilities	525.00	18 278.63
Repairs	123 235.43	86 519.12
Software and internet	10 381.21	20 386.34
Sponsorships and donations	50 000.00	-
Sundry expenses	13 515.08	54 285.57
Team member research costs	5 301 363.66	6 088 571.41
Transport and accommodation	409 890.33	327 365.59
Workshops	250 012.68	173 408.96
Personnel expenses	5 074 277.75	4 367 107.62
Salaries	5 074 277.75	4 367 107.62
SURPLUS FOR THE YEAR	1 792 976.22	590 391.29

APPENDICES: OUTPUTS FROM 2015

A. 1. Research

A. 1.1 Books

None in 2015

A. 1.2 Book chapters

Hill, M.P. and Thomson, L.J. (2015). Species Distribution Modelling in Predicting Response to Climate Change. In: *Climate Change and Insect Pests.* Björkman, C. and Niemelä, P. (eds.). CABI, Oxfordshire, UK. pp. 16-35.

Hui, C. (2015). Carrying capacity of the environment. In: *International Encyclopedia of the Social & Behavioral Sciences (2nd Edition).* Wright, J.D. (ed.). Elsevier, Oxford. pp. 155-160.

Hui, C., Minoarivelo, H.O., Nuwagaba, S. and Ramanantoanina, A. (2015). Adaptive diversification in coevolutionary systems. In: *Evolutionary Biology: Biodiversification from Genotype to Phenotype.* Pantarotti, P. (ed.). Springer, Berlin. pp. 167-186.

Terblanche, J.S., Karsten, M., Mitchell, K.A., Barton, M.G. and Gibert, P. (2015). Physiological Variation of Insects in Agricultural Landscapes: Potential Impacts of Climate Change. In: *Climate Change and Insect Pests.* Björkman, C. and Niemelä, P. (eds.). CABI, Oxfordshire, UK. pp. 92-130.

A. 1.3 Published Conference Proceedings and Abstracts

Canavan, S., Wilson, J.R.U. and Richardson, D.M. (2015). Understanding the risks of an emerging global market for cultivating bamboo: considerations for a more responsible dissemination of alien bamboos. In: *10th World Bamboo Congress.* Damyang, Korea.

Kumschick, S. (2015). Alien species classification according to impact magnitude: filling the gaps. In: *13th international conference on the Ecology and Management of Alien Plant Invasions.* Waikoloa Beach, Hawaii. p. 51.

Woodford, D., Hui, C. and Weyl, O.L.F. (2015) The danger of inter-basin water transfer schemes in driving alien fish establishment. In: *Aquatic invasive alien species – top issues for their management*. Outcomes from the IFI/EIFAAC conference "Freshwater Invasives – Networking for Strategy" (FINS) Galway, Ireland, 9-11 April 2013. EIFAAC Occasional Paper No. 50. Rome: Food and Agriculture Organization of the United Nations.

A. 1.4 Peer-reviewed Journal Articles

Alexander, M.E., Adams, R., Dick, J.T.A. and Robinson, T.B. (2015). Forecasting invasions: resource use by mussels informs invasion patterns along the South African coast. *Marine Biology* **162**, 2493-2500.

Alexander, M.E., Dick, J.T.A. and O'Connor, N.E. (2015). Predation in the marine intertidal amphipod *Echinogammarus marinus* Leach: implications of inter- and intra-individual variation. *Journal of Experimental Marine Biology and Ecology* **462**, 50-54.

Alexander, M.E., Kaiser, H., Weyl, O.L.F. and Dick, J.T.A. (2015). Habitat simplification increases the impact of a freshwater invasive fish. *Environmental Biology of Fishes* **98**, 477-486.

Alexander, M.E., Raven, H.J. and Robinson, T.B. (2015). Foraging decisions of a native whelk, *Trochia cingulata Linnaeus*, and the effects of invasive mussels on prey choice. *Journal of Experimental Marine Biology and Ecology* **470**, 26-33.

Anderson, W.R., Cruz, M.G., Fernandes, P.M., McCaw, L., Vega, J.A., Bradstock, R.A., Fogarty, L., Gould, J., McCarthy, G., Marsden-Smedley, J.B., Matthews, S., Mattingley, G., Pearce, H.G. and van Wilgen, B.W. (2015). A generic, empirical-based model for predicting rate of fire spread in shrublands. *International Journal of Wildland Fire* **24**, 443-460.

Azarkina, G.N. and Foord, S.H. (2015). A review of three *Tusitala* (Araneae: Salticidae) species from southern Africa, with a new synonymy and description of a new species from Botswana. *African Invertebrates* **56**, 285-307.

Baeckens, S., Edwards, S., Huyghe, K. and Van Damme, R. (2015). Chemical signalling in lizards: an interspecific comparison of femoral pore numbers in Lacertidae. *Biological Journal of the Linnean Society* **114**, 44-57.

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Basson, C.H. and Clusella-Trullas, S. (2015). The behavior-physiology nexus: behavioral and physiological compensation are relied on to different extents between seasons. *Physiological and Biochemical Zoology* **88**, 384-394.

Bellingan, T.A., Woodford, D.J., Gouws, J., Villet, M.H. and Weyl, O.L.F. (2015). Rapid bioassessment of the effects of repeated rotenone treatments on invertebrate assemblages in the Rondegat River, South Africa. *African Journal of Aquatic Science* **40**, 89-94.

Beltra, A., Addison, P., Avalos, J.A., Crochard, D., Garcia-Mari, F., Guerrieri, E., Giliomee, J.H., Malausa, T., Navarro-Campos, C., Palero, F. and Soto, A. (2015). Guiding classical biological control of an invasive mealybug using integrative taxonomy. *PLoS One* **10**, e0128685, 14 pages. DOI: 10.1371/journal.pone.0128685.

Bishop, T.R., Robertson, M.P., van Rensburg, B.J. and Parr, C.L. (2015). Contrasting species and functional beta diversity in montane ant assemblages. *Journal of Biogeography* **42**, 1776-1786.

Blackburn, T.M., Dyer, E., Su, S. and Cassey, P. (2015). Long after the event, or four things we (should) know about bird invasions. *Journal of Ornithology* **156**, 15-25.

Blanchard, R., O'Farrell, P.J. and Richardson, D.M. (2015). Anticipating potential biodiversity conflicts for future biofuel crops in South Africa: incorporating spatial filters with species distribution models. *Global Change Biology Bioenergy* **7**, 273-287.

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Booth, A.J., Moss, S. and Weyl, O.L.F. (2015). Effect of rotenone on gill-respiring and plastron-respiring insects. *African Journal of Aquatic Science* **40**, 95-100.

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and Yule, C.M. (2015). Latitudinal gradient of nestedness and its potential drivers in stream detritivores. *Ecography* **38**, 949-955.

Cheng, X.F., Shi, P.J., Hui, C., Wang, F.S., Liu, G.H. and Li, B.L. (2015). An optimal proportion of mixing broad-leaved forest for enhancing the effective productivity of moso bamboo. *Ecology and Evolution* **5**, 1576-1584.

Conlon, J.M., Mechkarska, M., Coquet, L., Leprince, J., Jouenne, T., Vaudry, H. and Measey, G.J. (2015). Evidence from peptidomic analysis of skin secretions that allopatric populations of *Xenopus gilli* (Anura: Pipidae) constitute distinct lineages. *Peptides* **63**, 118-125.

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Driscoll, D.A., Catford, J.A., Barney, J.N., Hulme, P.E., Inderjit, Martin, T.G., Pauchard, A., Pyšek, P., Richardson, D.M., Riley, S. and Visser, V. (2015). Reply to Proenca et al.: Sown biodiverse pastures are not a universal solution to invasion risk. *Proceedings of the National Academy of Sciences of the United States of America* **112**, E1696, 1 pages. DOI: 10.1073/pnas.1500548112.

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Esler, K.J., von Staden, L. and Midgley, G.F. (2015). Determinants of the Fynbos/Succulent Karoo biome boundary: insights from a reciprocal transplant experiment. *South African Journal of Botany* **101**, 120-128.

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Zengeya, T.A., Booth, A.J. and Chimimba, C.T. (2015). Broad niche overlap between invasive Nile tilapia *Oreochromis niloticus* and indigenous congenerics in Southern Africa: should we be concerned? *Entropy* **17**, 4959-4973.

Zhao, Z.H., Hui, C., He, D.H. and Li, B.L. (2015). Effects of agricultural intensification on ability of natural enemies to control aphids. *Scientific Reports* **5**, #8024, 7 pages. DOI: 10.1038/srep08024.

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A. 1.5 Products, artefacts and patents

None in 2015

A. 1.6 Conferences attended

International plenary/keynote addresses

Richardson, D.M. 2015. Invasion science for society – Tree invasions in South Africa as a case study. Trends in Biodiversity and Evolution 2015 Conference on "Global biodiversity change - from genes to ecosystems", Vairão, Portugal. June 2015 (Opening keynote talk)

Richardson, D.M. Is a "model group" focus the key to progress in plant invasion science? 13th International Conference on Ecology and Management of Alien Plant Invasions (EMAPI), September 2015, Kona, Hawaii (keynote talk)

National plenary/keynote addresses

Richardson, D.M. 2015. Industrial plantation species as invaders: A global review and options for management. Research Symposium on "Underpinning sustainable tree plantations in Southern Africa"; pre-congress meeting linked to the World Forestry Congress (WFC2015), September 2015, Durban, South Africa (invited keynote talk)

Richardson, D.M. 2015. Invasion science for society: Challenges and opportunities in South Africa. Joint conference of the Entomological Society of South Africa and the Zoological Society of South Africa, Rhodes University, Grahamstown, July 2015 (invited keynote talk)

International oral contributions

Alexander, M.E., Raven H., Robinson T.B. Foraging decisions of a native whelk, *Trochia cingulata*, and the effects of invasive mussels on prey choice. Aquatic Biodiversity and Ecosystems Conference, Liverpool, UK, September 2015

Diedericks G., Von der Heyden S., Weyl O.L.F., Hui C. 2015. Does source-sink dynamics facilitate the invasive success of *Micropterus dolomieu*? Aquatic Biodiversity & Ecosystems, Liverpool, UK. 30th August - 4th September 2015. http://www.aquaticbiodiversityandecosystems.org/wp-content/uploads/2015/01/ABEC-Abstract-Book-sml.pdf

Esler, K.J., Slingsby, J., Alsopp, N. Overview of biodiversity conservation research in Mediterranean-type ecosystems of the world. Invited speaker at Symposium "Overview of biodiversity conservation research in Mediterranean-type ecosystems of the world". 27th International Congress for Conservation Biology, Montpelier, France 2-6 August 2015

Esler, K.J., von Staden, L., Midgley, G. Determinants of the Fynbos/Succulent Karoo boundary: insights from a reciprocal transplant experiment. Invited speaker at international symposium "Plant diversity in the GCFR: from genomes to biomes", Kirstenbosch Botanical Gardens, 2 July 2015

Foxcroft, L.C. and Novoa, A. Impacts of *Opuntia stricta* on biodiversity, ecosystem function and social perceptions in Kruger National Park, South Africa. International Ecology and Management of Alien Plant Invasions Conference, Hawaii Island, Hawaii, September 2015

Hart, L.A., Johnson, S.D., Downs, C.T. 2015. The effect of Wahlberg's Epauletted Fruit Bats (*Epomophorus wahlbergi*) on alien invasive seed germination and their potential as dispersal agents. 6th International Symposium- Workshop on Frugivores & Seed Dispersal, Alpine Heath, June 2015

Impson N.D., Barrow S., van der Walt R., and Weyl, O.L.F. 2015. Challenges and Successes Facing South Africa's Endemic Species Recovery in the Future: The Rondegat River Experience. Watershed Scale Piscicide-Driven Restoration Efforts: Challenges and Successes in Endemic Species Recovery, American Fisheries Society, 145th Annual Meeting, 16-20 August 2015, Portland, Oregon, USA. https://afs.confex.com/afs/2015/webprogram/Paper21015.html

Kumschick S (2015) Invasive species risk analysis in South Africa. „Biodiversité de l'Ocean Indien", Université de la Réunion, France, June 2015

Kumschick, S. and SImpact group (2015) Alien species classification according to impact magnitude: filling the gaps. 13th international conference on the Ecology and Management of Alien Plant Invasions, Waikoloa Beach, Hawaii, September 2015

Le Roux, J.J. 2015. Environmental heterogeneity causes divergence, but not cross-generational carryover, of epigenetically regulated gene expression in a clonal grass. EMAPI, Waikoloa Village, Hawaii, USA. September 2015

Mokotjomela, T.M, Hoffmann, J.H. & Downs C.T. The potential for birds to disperse the seeds of *Acacia cyclops*, an invasive alien plant in South Africa. 6th International Symposium- Workshop on Frugivores & Seed Dispersal, Alpine Heath, June 2015.

Richardson, D.M. Invasives and seed dispersal. 6th International Symposium on "Frugivores & Seed dispersal", June 2015, Drakensberg, South Africa

Rius M., Clusella-Trullas S., McQuaid C.D., Navarro R.A., Griffiths C.L., Matthee C.A., von der Heyden S. and Turon X. Range expansions across ecoregions: interactions of climate change, physiology and genetic diversity. International Biogeography Society 7th biennial conference, University of Bayreuth, Germany January 2015

Robertson, M.P. Biosecurity challenges in mountains: perspectives from southern Africa. Talk given at: Biosecurity in Mountains and Northern Ecosystems: Current Status and Future Challenges", Flen, Sweden, June 2015

Sadchatheswaran, S., Branch, G.M., Robinson, T.B. Skyscrapers to bungalows: sequential invasions change rocky shore ecology. Aquatic Biodiversity and Ecosystems Conference in Liverpool, UK, September 2015

Strydom, M., Veldtman, R., Ngwenya, M.Z., Esler, K.J. 2015. Australian Acacia seed banks: Wattle lot they got! Ecology and Management of Alien Plant Invasions (EMAPI) 2015 20-24 September, Waikoloa Village, Hawaii

Thabethe, V., Wilson, A-L., Hart, L.A. & Downs, C.T. 2015. Effect of invasive and indigenous avian species on seed germination of fleshy-fruited invasive alien plants in South Africa. 6th International Symposium- Workshop on Frugivores & Seed Dispersal, Alpine Heath, June 2015

Weyl, O.L.F, Ellender, B.R., Woodford, D.J., Taylor, G.C., Peel, R., Hill, J. (2015). Understanding the impacts of African sharptooth catfish *Clarias gariepinus* invasions: a need for international research collaboration. 15th congress of the Ichthyological Society of Brazil. January 2015

Weyl, O.L.F. (2015). Understanding the potential ecological impacts of an emerging species in global aquaculture – the African sharptooth catfish *Clarias gariepinus*. 15th congress of the Ichthyological Society of Brazil. January 2015

Weyl, O.L.F., Barrow, S., Impson, N.D., Esler, K.J., Finlayson, B., Jordaan, M., Woodford D.J. (2015). Response of Endemic Species in South Africa's Rondegat River to Removal of Smallmouth Bass.

Watershed Scale Piscicide-Driven Restoration Efforts: Challenges and Successes in Endemic Species Recovery, American Fisheries Society, 145th Annual Meeting, 16-20 August 2015, Portland, Oregon, USA. https://afs.confex.com/afs/2015/webprogram/Paper18792.html

Wilson, J. Stratégie gouvernementale de lutte contre les plantes envahissantes en Afrique du Sud [in English], Biodiversity Symposium, La Rèunion, 2–5 June 2015

Wilson, J. The theory and practice of incursion response 13th International Conference on the Ecology and Management of Alien Plant Invasions, Hawaii Island, 20–24 September 2015

National oral contributions

Alexander, M.E., Raven H., Robinson T.B. Foraging decisions of a native whelk, *Trochia cingulata*, and the effects of invasive mussels on prey choice. 37th Congress of the Zoological Society of Southern Africa. Grahamstown, South Africa, July 2015

Bellingan, T., Jackson, M., Woodford, D., Villet, M. and Weyl, O.L.F. (2015). Community and food web structure in the Keiskamma River system: A century after the introduction of invasive trout. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Coppinger, C.R., Ellender, B.R., Tarrant, J., Corrigan, B., Armstrong, N. and Weyl, O.L.F. (2015). Conservation of headwater species and habitats in the Amathole Mountains: opportunities and challenges. Southern African Society of Aquatic Scientists Conference, Champagne Sports Resort, KZN, 29 June – 2 July 2015

Dalu, T., Wassermann, R.J., Alexander, M.E., Froneman, P.W. and Weyl, O.L.F. (2015). Emergent impacts of structural complexity and temperature on Notonectid-Daphnia predator-prey dynamics. Zoological Society of Southern Africa (ZSSA) Conference, Grahamstown 16-17 July 2015. http://www.essa-zssa2015.co.za/images/ZSSA_Abstracts_Alphabetized.07_July.pdf

Davies, S.J., Hill, M.P., McGeoch, M.A. and Clusella-Trullas, S. 2015. Painting on a new canvas: Invasive reed frogs occupy a novel niche in South Africa's Mediterranean ecosystems. Oral presentation at the 37th Congress of the Zoological Society of Southern Africa. Rhodes University, Grahamstown, South Africa. 12 - 17 July

De Villiers, F.A., Altwegg, R.A. & Measey, G.J. The age structure and survival of Cape Xenopus (Anura: Pipidae). Zoological Society of Southern Africa, Grahamstown, South Africa, July 2015.

Edwards, S., Herrel, A., Vanhooydonck, B., Measey, G.J. & Tolley, K.A. Morphology and performance is linked to predator escape strategy in desert lizards (Meroles, Lacertidae, Squamata). Zoological Society of Southern Africa, Grahamstown, South Africa, July 2015

Ellender, B.R., Coppinger, C.R. and Weyl, O.L.F. (2015). Spatio-temporal population dynamics on non-native fish invasion fronts and their impacts on native fish communities. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Faulkner, K.T., Robertson, M.P., Rouget, M., Wilson J.R.U. The pathways of introduction for alien species in South Africa and the consequences for management. Entomological Society of Southern Africa conference, Grahamstown, July 2015

Griffiths, C.L. - Marine aliens in South Africa- state of the nation. ZSSA/ESSA Joint Conference. Grahamstown, July 2015

Jordaan, M. and Weyl O.L.F. (2015). Evaluation of the acute toxicity of the piscicide rotenone to the sharptooth catfish *Clarias gariepinus*. Joint Entomological Society of Southern Africa/ Zoological Society of Southern Africa Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Krupek, A., Gaertner M., Holmes, P.M. & Esler, K.J. Post-burn removal methods for *Acacia saligna* in Cape Flats Sand Fynbos, Fynbos Forum, Montagu, South Africa, August 2015

Kumschick, S. How to assess the risks posed by intentionally introduced terrestrial invertebrates? Joint Congress of the ESSA and ZSSA: Rhodes University, Grahamstown, South Africa, 15 July

Marneweck, D.G., Druce, D.G., Marnewick, K. & Somers, M.J. The effect of wild dogs (*Lycaon pictus*) and rainfall on herbivores in Hluhluwe-iMfolozi Park, South Africa. South African Wildlife Management Association annual symposium, Kimberley, South Africa, September 2015

Measey, G.J., Vimercati, G., de Villiers, F.A., Mokhatla, M.M., Davies, S.J., Edwards, S. & Altwegg, R. (2015). Frog eat frog. Zoological Society of Southern Africa Conference, Grahamstown, South Africa, July 2015

Mofu, L., Weyl, O.L.F., Woodford, D.J. (2015). Assessing the biology of the River Goby as a proxy to understand global goby invasions. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Mokhatla, M.M., Measey, G.J. & Smit, B. The role of temperature and ecology on the physiology of three southern African anurans. Zoological Society of Southern Africa, Grahamstown, South Africa, July 2015.

Ndaleni, P., Wassermann, R., Alexander, M., Ellender, B.R. and Weyl O.L.F. (2015). A comparison of predatory functional responses of four non-native fish species from a South African river system. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Strydom, M., Ngwenya, M., Veldtman, R. and Esler, K.J. Characterising Australian Acacia seed bank size and its relationship with stand characteristics in the Western Cape. 57th Annual Conference of the South African Statistical Association, University of Pretoria, 29 November to 2 December 2015

Picker, M.D. & Griffiths, C.L. Trends and current status of alien invertebrates in South Africa ZSSA/ ESSA Joint Conference. Grahamstown, July 2015

Pillay, K., Ramesh, T. & Downs, C.T. 2015. Home range and habitat use of feral cats along an urban gradient in Pietermaritzburg, South Africa. ZSSA Grahamstown, July 2015

Rebelo, A. & Measey, G.J. Morphological and reproductive traits correlate with distribution range size within a southern African frog radiation (Anura: Pyxicephalidae). Zoological Society of Southern Africa, Grahamstown, South Africa, July 2015

Robertson, M.P. Ant diversity in Highveld grassland rehabilitation. Entomological Society of Southern Africa conference, Grahamstown, July 2015

Shelton, J.M., Dallas, H.F., Weyl, O.L.F. and Esler K.J. (2015). Influence of climate warming on interactions between invasive and native freshwater fish in the Cape Floristic Region. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Sibiya, T.E., Esler, K.J., Foxcroft, L.C. Riparian plant community change and alien plant invasions following geomorphological change in the Sabie River, Kruger National Park. Savanna Science Network Meeting, Mpumalanga, South Africa, March 2015

Sibiya, T.E., Esler, K.J., Foxcroft, L.C. Riparian plant community change and alien plant invasions following geomorphological change in the Sabie River, Kruger National Park. GSN Indibano Conference and R workshop in Kimberly, South Africa, September 2015

Thorp, C.J., Alexander, M., Vonesh, J., & Measey, G.J. Does size matter? A comparative functional response study in adult Xenopus predation. Zoological Society of Southern Africa, Grahamstown, South Africa, July 2015

Vimercati, G., Measey, G.J., Davies, S.J. & Hui, C. Invasion or eradication? Testing the efficacy of the guttural toad (*Amietophrynus gutturalis*) eradication program in Cape Town through individual based modelling. Zoological Society of Southern Africa, Grahamstown, South Africa, July 2015

Vitule, J.R.S. and Weyl, O.L.F. (2015). Understanding invasion status and risks of an emerging species in the global aquaculture industry – the African sharptooth catfish *Clarias gariepinus*. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Wassermann, R.J., Alexander, M.E., Dalu, T., Kaiser, H., Weyl OLF. (2015). Multiple predator effects and the cost of intra- and interspecific interference: a functional response approach. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Weyl, O.L.F. (2015). Rotenone use to control alien invasive species: a South African case study. Water Research Commission, Ecosystems Research & Innovation Symposium, Broederstroom, Hartbeespoort, 17-18 February 2015

Weyl, O.L.F. (2015). The trouble with inland fisheries development in South Africa. Southern African Society of Aquatic Scientists Conference, Champagne Sports Resort, KZN, 29 June – 2 July 2015

Weyl, O.L.F. (2015). Yellowfish fisheries – do we know enough for effective management? 19TH Yellowfish Working Group Conference, Champagne Sports Resort, KZN 28 June. http://www.fosaf.co.za/documents/YWG-Conference-Proceedings-2015.pdf

Weyl, O.L.F., Barrow S., Ellender, B.R., Impson, N.D., Jordaan, M. and Woodford, D.J. (2015). Native fish responses to the removal of an alien predator in the Rondegat River, South Africa. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

Woodford, D.J., MacIsaac, H., Richardson, D.M., Mandrak, N., van Wilgen, B.W., Wilson, J.R.U. and Weyl O.L.F. (2015). Confronting the wicked problem of managing invasive species. Joint Entomological Society of Southern Africa (ESSA)/ Zoological Society of Southern Africa (ZSSA) Conference: Invasions Day. Grahamstown 15 July 2015. http://www.essa-zssa2015.co.za/images/Invasions_Abstracts_Alphabetized.07_July.pdf

International posters

Lavhelesani D. Simba, Foord, S.H., Elisa Thébault, F. J. Frank van Veen and Colleen L. Seymour. Pollinator spill-over effects and potential indirect interactions between mango fields and the surrounding natural vegetation. 45th Annual Meeting of the Ecological Society of Germany, Austria and Switzerland, Göttingen, 31 August – 4 September 2015

Steyn, V.M., Mitchell, K.A., Terblanche, J.S. Dispersal propensity, not physiological performance, explains variation in dispersal behavior. Society for Experimental Biology Annual Main Meeting, Prague, July 2015

National posters

Dippenaar-Schoeman, A.S., Lyle, R, Haddad, C.R., Foord, S.H., Lotz, L. The South African National Survey of Arachnida (SANSA) – the way forward. XIX ESSA and the 37th ZSSA Congress, Rhodes University, Grahamstown, July 2015

Mauda, E.V., Foord, S.H., Munyai, T.C. Ant diversity in an arid peri-urban landscape of the Vhembe Biosphere, South Africa. XIX ESSA and the 37th ZSSA Congress, Rhodes University, Grahamstown, July 2015

Munyai, T.C., Foord, S.H. An inventory of epigeal ants of the western Soutpansberg mountain range, South Africa. XIX ESSA and the 37th ZSSA Congress, Rhodes University, Grahamstown, July 2015

Schoeman C.S., Foord S.H. and Hamer M. Sample coverage and spider species richness estimates in the Vhembe Biosphere Reserve. XIX ESSA and the 37th ZSSA Congress, Rhodes University, Grahamstown, July 2015

Webster, A.B. & Somers, M.J. (2015). Meso-predator activity patterns in grassland and riparian landscapes. 6th Annual Diamond Route Research Conference, Johannesburg, October 2015

A. 2. Education and training

A. 2.1 Students supported by the Centre in 2015

Name	Citizenship	Institution	Race	Gender	Status	Funding level*
BSc (Honours)/4th year BAgric.						
Ms Skye Butterson	SA	SU	Coloured	F	Completed	Full
Ms Silindile Gumede	SA	UKZN	Black	F	Completed	Full
Ms Monique Laubscher	SA	SU	White	F	Completed	Partial
Ms Inge Marx	SA	SU	White	F	Completed	Independent
Ms Mulalo Muluvhahothe	SA	UniVen	Black	F	Completed	Full
Mr Jufter Musedeli	SA	UniVen	Black	M	Completed	Full
Ms Nicola Rule	SA	UCT	White	F	Completed	Partial
Masters						
Mr Brent Abrahams	SA	SU	Coloured	M	Continuing	Full
Ms Patricia Begwa	SA	North West	Black	F	Continuing	Independent
Mr Casey Broom	SA	SU	White	M	Continuing	Independent
Ms Laura Caetano	SA	SU	Coloured	F	Completed	Independent
Ms Susan Canavan	Irish	SU	White	F	Continuing	Partial
Mr André de Villiers	SA	SU	White	M	Completed	Partial
Mr Brendon Dredge	SA	Rhodes	White	M	Completed	Partial
Mr Zishan Ebrahim	SA	SU	Coloured	M	Continuing	Independent
Ms Hermina Fourie	SA	UP	White	F	Current	Full
Mr Llewellyn Jacobs	SA	SU	Coloured	M	Continuing	Independent
Mr Jacques Jansen van Rensburg	SA	SU	White	M	Continuing	Independent
Ms Natasha Kruger	SA	North West	White	F	Continuing	Partial
Ms Asiashu Lithole	SA	UP	Black	F	Continuing	Independent
Ms Amy Liu	SA	SU	Asian	F	Completed	Independent
Ms Joy Mangachena	Zimbabwean	CPUT	Black	F	Continuing	Partial
Mr Mashudu Mashau	SA	SU	Black	M	Continuing	Independent
Ms Vanessa Matukana	SU	UniVen	Black	F	Resigned	Independent
Mr Phil McLean	SA	SA	White	M	Continuing	Partial
Mr Lubabalo Mofu	SA	Rhodes	Black	M	Completed	Full
Ms Elana Mostert	SA	SU	White	F	Completed	Full
Ms Mukundi Mukundamago	SA	SU	Black	F	Completed	Independent
Mr Vuledzani Mukwevho	SA	SU	Black	M	Completed	Independent
Ms Phumza Ndaleni	SA	Rhodes	Black	F	Continuing	Full
Mr Phathutshedzo Netshabumu	SA	SU	Black	M	Completed	Full
Mr Mlungele Nsikani	Zimbabwean	SU	Black	M	Continuing	Full
Mr David Phair	SA	SU	White	M	Completed	Partial
Ms Kerushka Pillay	SA	UKZN	Indian	F	Completed	Full
Mr Alexander Rebelo	SA	SU	White	M	Continuing	Independent
Mr Ntaki Senoge	SA	UKZN	Black	M	Continuing	Partial
Ms Thabang Sibiya	SA	SU	Black	F	Continuing	Independent
Mr Vernon Steyn	SA	SU	White	M	Completed	Partial

Name	Citizenship	Institution	Race	Gender	Status	Funding level*
Mr Thomas Stielau	SA	UCT	White	M	Continuing	Partial
Mr Corey Thorp	SA	SU	White	M	Continuing	Independent
Mr Mark Turnbull	SA	UJ	White	M	Continuing	Independent
Mr Gareth Walker	SA	SU	White	M	Continuing	Independent
PhD-Upgrade						
Ms Jessica Allen	SA	SU	White	F	Completed	Independent
Mr Stuart Hall	SA	SU	White	M	Continuing	Partial
Mr Ross Shackleton	SA	SU	White	M	Completed	Full
PhD						
Mr Antoine Bahizi	Rwandan	SU	Black	M	Continuing	Full
Mr Terence Bellingan	SA	Rhodes	White	M	Continuing	Independent
Ms Maria Castillo	Chilean	SU	White	F	Continuing	Full
Mr Chad Cheney	SA	SU	White	M	Continuing	Independent
Ms Genevieve Diedericks	SA	UP	White	F	Continuing	Full
Ms Katelyn Faulkner	SA	SU	White	F	Completed	Independent
Ms Rolanda Julius	SA	UP	Coloured	F	Current	Full
Ms Clova Jurk-Mabin	UK	SU	White	F	Continuing	Partial
Ms Siviwe Lamani	SA	SU	Black	F	Continuing	Full
Ms Sandra MacFadyen	SA	SU	White	F	Continuing	Independent
Ms Ingrid Minnaar	SA	SU	White	F	Continuing	Full
Ms Onivola Minoarivelo	Malagasy	SU	Black	F	Completed	Independent
Mr Mohlamatsane Mokhatla	SA	SU	Black	M	Continuing	Independent
Ms Desika Moodley	SA	UKZN	Indian	F	Continuing	Independent
Mr Caswell Munyai	SA	UniVen	Black	M	Completed	Independent
Ms Savannah Nuwagaba	Ugandan	SU	Black	F	Continuing	Independent
Ms Koebraa Peters	SA	SU	Coloured	F	Continuing	Partial
Ms Unjinee Poonan	SA	Wits	Indian	F	Completed	Independent
Ms Saachshaini Sadchatheeswaran	Canadian	UCT	Coloured	F	Continuing	Independent
Ms Likho Sikutshwa	SA	SU	Black	F	Continuing	Partial
Mr Matthys Strydom	SA	SU	White	M	Completed	Full
Mr Giovanni Vimercati	Italian	SU	White	M	Continuing	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*
Dr Mhairi Alexander	UK	SU	White	F	Resigned	Full
Dr Bruce Ellender	SA	SAIAB	White	M	Resigned	Independent
Dr Katelyn Faulkner	SA	SU	White	F	Continuing	Independent
Dr Jennifer Fill	USA	SU	White	F	Continuing	Full
Dr Raquel Garcia	Portuguese	SU	White	F	Continuing	Full
Dr Matthew Hill	Australian	SU	White	M	Resigned	Full
Dr Heidi Hirsch	German	SU	White	F	Continuing	Full
Dr Michelle Jackson	UK	UP	White	F	Continuing	Independent
Dr Michael Latter Logan	USA	SU	White	M	Continuing	Independent
Dr Matthew McConnachie	SA	SU	White	M	Resigned	Independent
Dr Natasha Mothapo	SA	SU	Black	F	Resigned	Full
Dr Ana Novoa	Spain	SU	White	F	Continuing	Independent
Dr Ana-Luisa Nunes	Portugal	SU	White	F	Continuing	Full
Dr Jeremy Shelton	SA	SU	White	M	Continuing	Independent
Dr Vernon Visser	SA	SU	White	M	Resigned	Independent
Dr Ryan Wasserman	SA	SAIAB	White	M	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

Bengtsson, Prof. Janne, Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden. Discussions on invasions in soil (Richardson)

Bishop, Mr Tom, University of Liverpool. PhD student on Sani Pass ant diversity project (Robertson).

Crookes, Dr Steven, Great Lakes Institute for Environmental Research, University of Windsor and Prof. Nicholas Mandrak, Department of Biological Sciences, University of Toronto Scarborough. Collaborator on assessing silver carp distribution using e-DNA in Kruger National Park (Foxcroft)

Downey, Prof. Paul, Institute for Applied Ecology, University of Canberra, Australia. Collaborator on assessing and refining the use of strategic adaptive management for invasive species management in SANParks (Foxcroft)

Evans, Prof. Ben, McMaster University (CIB fellow) Collaborator on *Xenopus* hybridisation (Measey)

Galetti, Prof. Mauro, Departamento de Ecologia, Universidade Estadual Paulista, Brazil. Collaborator on Frugivores & Seed Dispersal (Downs)

Hamid, Prof. Zakri Abdul, Chair, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Science Advisor to Malaysia's Prime Minister. General discussions on IPBES and the role of invasive species (Richardson)

Jansen, Prof. Patrick, Department of Environmental Sciences, Wageningen University, the Netherlands. Collaborator on Frugivores & Seed Dispersal (Downs)

Mandrak, Prof. Nicholas, University of Toronto Scarborough. Collaborator on developing novel detection techniques for AIS (Weyl)

McCoy, Dr Mike, University of East Carolina, USA. Collaborator on trophic linkages in the Sundays River (Weyl)

McCoy, Prof. Mike, (CIB fellow) Collaborator on size dependent functional response (Measey)

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

Nartey, Dr Vincent, Chairman, Environmental Protection Agency, Ghana. Exploratory visit to discuss potential collaborations (Richardson)

Nathan, Prof. Ran, Movement Ecology Lab, Department of Ecology, Evolution and Behavior, The Hebrew University of Jerusalem, Jerusalem, Israel. Collaborator on Frugivores & Seed Dispersal (Downs)

Panetta, Prof. F. Dane, University of Melbourne. Collaboration on incursion response planning (Wilson)

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

Starostova, Dr Zusana, Department of Zoology, Charles University in Prague. Collaborator on a project exploring the developmental plasticity of *Harmonia axyridis* and its potential benefits to the dispersal of this species in novel environments. (Clusella-Trullas)

Strasberg, Prof. Dominique, University of La Réunion, Saint-Denis. Collaboration on alien species risk assessments in Indian Ocean countries (Kumschick)

Strasberg, Prof. Dominique, University of La Réunion. Collaboration on invasions in the Mascarenes (Wilson, van Wilgen, Richardson, Measey)

van Rensburg, Dr Berndt, University of Queensland. Collaborator on Sani Pass ant diversity project (Robertson)

Virtue, Dr John, Biosecurity South Australia. Discussion on Biosecurity (Richardson, Wilson)

Vonesh, Prof. James, Virginia Commonwealth University, Department of Biology (US Fulbright Fellow). Collaborator on amphibian life history (Measey)

Vonesh, Prof. James, Virginia Commonwealth University, Department of Biology (US Fulbright Fellow). Collaborator on trophic linkages in the Sundays River (Weyl)

Zengeya, Dr Tsungai, SANBI, Pretoria. Collaborator on aquatic ecology (Chimimba).

A. 3.2 Academic visits by core team members to other institutions

BELSPO (Belgian Science Policy Office), Brussels, Belgium. Collaboration on invasive alien trees in Europe, impacts and risk assessment thereof with Mr Etienne Branquart, Dr Sonia Vanderhoeven (both Departement d'Etude du Milieu Naturel et Agricole, Belgium) and Dr Bram D'Hondt (post-doctoral researcher at Ghent University, Belgium) (Kumschick)

CABI Switzerland, Delemont, Switzerland. Participation in project planning for East African Woody Weeds project (Le Roux, van Wilgen)

CABI, Delemont, Switzerland. Collaboration on risk assessment and intentional movement of terrestrial invertebrates with Dr Marc Kenis (Kumschick)

Centre for Invasion Biology, Stellenbosch University. Collaborator on an alien species risk analysis framework for South Africa with Dr Sabrina Kumschick (Foxcroft)

Conservation Ecology and Entomology, Stellenbosch University. Collaboration on alien plant distributions in protected areas and riparian ecosystems with Prof. Karen Esler (Foxcroft)

Department of Biology, Ecology and Evolution, University of Fribourg, Switzerland. Collaboration on socioeconomic impacts of alien species, and a generic scoring system with Prof. Sven Bacher (Kumschick)

Department of Plant Biology, University of Vermont, USA. Workshop with Prof. Jane Molofsky, Prof. Nick Gotelli and others on deriving patterns in plant invasions from late data sets. (Richardson)

Department of Zoology, University of British Columbia, Canada. Collaboration on insect respiratory chemoreceptors with Prof. Phil Matthews (Terblanche)

Kenya Forestry Research Institute, Nairobi. Participation in stakeholders meeting and project planning for East African Woody Weeds project (Le Roux, van Wilgen)

National Socio-Environmental Synthesis Centre, Annapolis, USA. Participation in workshop on large transdisciplinary projects (van Wilgen, Esler)

SANParks offices, Kruger National Park, Skukuza, South Africa. Collaboration on an alien species Risk Analysis Framework for South Africa with Dr Llewellyn Foxcroft (Kumschick)

School of Biological Sciences, Monash University, Australia. Collaboration on species turnover patterns with Prof. Melodie McGeoch (Hui)

Scientific Services, Skukuza, Kruger National Park. Development of bibliometric assessment of publications (van Wilgen)

Tanzanian Forestry Research Institute, Amani, Tanzania. Participation in stakeholders meeting and project planning for East African Woody Weeds project (van Wilgen)

Université de la Reunion, La Reunion, France. Collaboration on an Indian Ocean biodiversity project with Profs Dominique Strasberg and John Wilson (Kumschick)

University of British Columbia (Vancouver), Prof. Patricia Schulte, sabbatical. (Clusella-Trullas)

University of Toronto Scarborough, Collaboration on developing novel detection techniques for AIS with Nicholas Mandrak (Weyl)

A. 3.3 Travel awards to core team members, post-doctoral associates and students

C·I·B travel award to Mr Giovanni Vimercati for best PhD presentation at the 2015 Annual Research Meeting (Measey)

HB Thom award to Prof. Jaco Le Roux towards sabbatical research visit to Lincoln University, New Zealand (Le Roux)

NRF Innovative bursary linked travel award for Mr Mohlamatsane Mokhatla to attend international PhD course modelling species distributions under climate change hosted by the Center for Macroecology, Evolution and Climate (Natural History Museum of Denmark) (Measey)

NRF KIC Award to Dr Matt Hill to travel to Denmark and UK. Gave talk at the European Macroecology Conference in Copenhagen, Denmark, 14-16 June. (Terblanche)

Oppenheimer Memorial Trust award to Prof. Jaco Le Roux towards sabbatical research visit to Lincoln University, New Zealand (Le Roux)

Postgraduate and International Office (PGIO) Overseas Conference Grant (OCG), Department of Conservation Ecology Travel Grant and Faculty of Agriculture Post Graduate Conference Travel Support award for Dr Matthys Strydom to attend EMAPi meeting in Waikoloa, Hawaii (Esler)

Regional Training Course on Fruit Fly Monitoring and Suppression including MAT and release of sterile Fruit Flies, attended by Ms Minette Karsten, Reduit, Mauritius, 29 June-3 July. (Terblanche)

SAEON-GSN travel award for Ms Thabang Sibiya to attend 2015 GSN Indibano Conference and R workshop in Kimberley, South Africa (Foxcroft, Esler)

SESYNC Travel award for Profs Karen Esler and Brian van Wilgen and students Dr Ross Shackleton and Mr Brent Abrahams to attend SESYNC 'Design considerations for complex integrated projects' meeting in Annapolis, Maryland, USA (Esler).

SESYNC Travel award to Mr. Stuart Hall to attend SESYNC "BIOESS (Biodiversity and Ecosystem Services Collaboration) workshop in Annapolis, Maryland, USA (Esler)

Student conference attendance funding for Ms Saachi Sadchatheswaran to attend the Aquatic Biodiversity and Ecosystems Conference in Liverpool, UK (Robinson)

A. 3.4 Research collaborations

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

Alien plant distribution in protected areas and evidence based management. Collaborators: Prof. Karen Esler, Conservation Ecology and Entomology, Stellenbosch University, and Prof. Melodie McGeoch, School of Biological Sciences, Monash University. (Foxcroft)

Alien species Risk Analysis Framework for South Africa. Collaborators: Prof. John Wilson, SANBI and Centre for Invasion Biology, Stellenbosch University; Dr Llewellyn Foxcroft, SANParks and CIB, Stellenbosch University (Kumschick)

Ants assembly on islands. Collaborators: Dr Nuria Roura-Pascual, University of Girona, Spain; and Prof. Nate Sanders, University of Copenhagen, Denmark (Hui)

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 Prof. Nicholas Mandrak, Department of Biological Sciences, University of Toronto Scarborough, Canada and Dr Olaf Weyl, South African Institute for Aquatic Scientists, Grahamstown, South Africa (Foxcroft)

Assessment of plant invasions and management effectiveness in Fynbos protected areas. Collaborators: Michael Braack, Working for Water; Dr Antoinette Veldtman, CapeNature; Dr Tineke Kraaij and Mr Chad Cheney, SANParks (van Wilgen)

Bibliometric analysis. Collaborators: Dr Izak Smit, Scientific Services, SANParks: and Dr Nelius Boshoff, CREST, SU (van Wilgen)

Biodiversity and human evolution. Collaborator: Prof. Curtis Marean, Institute of Human Origins. School of Human Evolution and Social Change, PO Box 872402, Arizona State University, Tempe, AZ 85287-2402 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).

Blacklisting of alien species. Collaborators: Prof. Melodie McGeoch, Monash University, Australia; and +10 others (Hui)

Carnivore Reintroduction Biology and effects on biodiversity, 2004-2015 – Collaborators: Dr Micaela Szykman, Humboldt State University; Dr Dave Wildt & Dr Steve Monfort, Smithsonian Institute; Dr Kelly Marnewick, Endangered Wildlife Trust; Dr Matt Hayward, Bangor University (Somers)

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

Chromolaena odorata and biodiversity in Hluhluwe-iMfolozi Park, 2011 – 2015. Collaborators, Dr Kate Parr, Oxford University (Somers)

Climate change implications of nocturnality and resource restriction for ectotherms across latitude. Dr Timothy C. Bonebrake, University of Hong Kong. (Clusella-Trullas)

Conservation monitoring of otters in Europe and South Africa, 2011-2015: Mr Zoltán Sallai, Hungarian National Parks; Dr István Lehoczky, HAKI; Dr József Lanszki, University of Kaposvár, Prof. Antoinette Kotzé and Mr Thabang Madisha, National Zoological Gardens, Dr Kelly Marnewick, Endangered Wildlife Trust; Dr Trevor McIntyre, University of Pretoria (Somers)

Determinants of species distributions in Mozambique, 2015-: Dr Marcus Rowcliff, Imperial College, London, UK (Somers)

Developmental plasticity of the invasive ladybird Harmonia axyridis and its potential effects on dispersal. Dr Zuzana Starostova, Department of Zoology, Charles University in Prague, Czech Republic. (Clusella-Trullas)

Distribution and population dynamics of roadside alien plants. Collaborator: Dr Jesse Kalwij, Institute of Ecology & Earth Sciences, University of Tartu, Tartu, Estonia (Robertson)

Documentation and assessment of large trans-disciplinary projects. Prof. Hal Mooney, Stanford, and Dr Margaret Palmer, National Socio-Environmental Synthesis Centre, Maryland, US (van Wilgen)

Eco-evolutionary dynamics. Collaborators: Dr Ulf Dieckmann, IIASA, Austria; and Prof. Åke Brännström, Umea University, Sweden (Hui)

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

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

Essential Biodiversity Variables for invasion monitoring. Collaborators: Prof. Melodie McGeoch, School of Biological Sciences, Monash University, Australia; Prof. Tim Blackburn, University College London, London; Prof. Piero Genovesi, ISPRA (Institute for Environmental Protection and Research), Italy; and Prof. John Wilson, SANBI and Centre for Invasion Biology, Stellenbosch University (Kumschick)

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

Generic Impact Scoring System. Collaborators: Sven Bacher, Department of Biology, Unit Ecology & Evolution, University of Fribourg, Switzerland; Mr Tom Evans, University College London, London; Ms Zuzana Marková, Institute of Botany, Academy of Sciences of the Czech Republic; Dr Jan Pergl, Institute of Botany, Academy of Sciences of the Czech Republic; Prof. 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; Prof. Dr Montserrat Vilà, Estación Biológica de Doñana (EBD-CSIC), Sevilla, Spain; and Prof. Dr Wolfgang Nentwig, Institute of Ecology and Evolution, University of Bern, Switzerland (Kumschick)

Global decomposition rate. Collaborators: Prof. Luz Boyero, University of the Basque Country, Spain; and +20 others (Hui)

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

Incursion Response Planning. Collaborators: Prof. Dane Panetta, University of Melbourne, Australia; and Dr Cory Lindgren, Canadian Food Inspection Agency, Canada (Wilson)

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

Intentional introductions of alien terrestrial invertebrates. Collaborators: Dr Marc Kenis, CABI, Delemont, Switzerland; Dr Wolfgang Rabitsch, Umweltbundesamt, Vienna, Austria; Prof. Dave Richardson, CIB, Stellenbosch University; and Prof. John Wilson, SANBI and Centre for Invasion Biology, Stellenbosch University (Kumschick)

International Plant Sentinel Network. Collaborators: Prof. Mike Wingfield, FABI, Pretoria; Prof. Wilhelm de Beer, FABI, Pretoria; Dr Christopher Willis, SANBI; Dr Francois Roets, Stellenbosch University (Wilson)

Invasive alien trees in Europe, impacts and risk assessment thereof. Collaborators: Mr Etienne Branquart, Departement d'Etude du Milieu Naturel et Agricole, Belgium; Dr Sonia Vanderhoeven, Departement d'Etude du Milieu Naturel et Agricole, Belgium; and Dr Bram D'Hondt, Ghent University, Belgium (Kumschick)

Invasive plants: Dr Jesse Kalwij, Institute for Ecosystem Research, Kiel University, Germany (Foord)

Investigating parasite-host dynamics in a fungal-ladybird system: is the invasive *Harmonia axyridis* facilitating the spread of *Hesperomyces virescens*? Mr Danny Healwaters, Harvard University, USA. (Clusella-Trullas)

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

Methods and approaches for the management of arthropod border incursions. Collaborators: Mrs Davina Saccaggi, Plant Health Diagnostic Services, Department of Agriculture, Forestry and Fisheries (DAFF), South Africa (Kumschick)

National Alien Grass Working Group (incl. bamboos). Collaborators: Mr Philip Ivey, Ms Ingrid Nänni, Dr Sebataolo Rahlao (SANBI); Ms Lyn Fish (SANBI); Dr David Le Maitre (CSIR); Ms Kim Canavan (Rhodes University) (Kumschick, Richardson)

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 Brandon Pratt, Department of Biology, California State University Bakersfield, 9001 Stockdale Highway, Bakersfield, California, USA (Esler)

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, US (Esler)

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

Pathways of invasion. Collaborators: Dr Franz Essl, Umweltbundesamt, Vienna, Austria; Prof. John Wilson, SANBI and Centre for Invasion Biology, Stellenbosch University; and Prof. Dave Richardson, CIB, Stellenbosch University (Kumschick)

Pathways of invasions. Collaborator: Dr Franz Essl, Division of Conservation Biology, Vegetation, and Landscape Ecology, University of Vienna, Austria (Various studies on invasion science) (Richardson)

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

Plant invasions in Angola. Collaborator: Prof. Marcel Rejmanek, Department of Evolution and Ecology of Ecology University of California, Davis, USA (Richardson)

Plant invasions on islands. Collaborator: Prof. Dominique Strasberg, Laboratoire de Biologie Végétale, Université de La Réunion, France (Le Roux, Richardson, Wilson)

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, Maulbeerallee 3, 14469 Potsdam, Germany (Esler)

Rattus in South Africa. Collaborators: Dr Armanda Bastos, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa; Dr Helene Brettschneider, National Zoological Gardens, Pretoria, South Africa; Dr Volker Schwan, Department of Veterinary Tropical Diseases, University of Pretoria, Pretoria, South Africa (Chimimba)

Regime shifts concepts and theories, modelling: Collaborators: Dr Reinette (Oonsie) Biggs Centre for Complex Systems in Transition, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa, Stockholm Resilience Centre, Stockholm University, Sweden and Prof. Cang Hui, Centre for Invasion Biology, Department of Mathematical Sciences, Stellenbosch University, Matieland 7602, South Africa; BioMath Group, African Institute for Mathematical Sciences, Cape Town 7652, South Africa (Gaertner)

Research into South African soil organisms (incl. earthworms). Collaborators: Dr Charlene Janion-Scheepers, University of Melbourne; Dr Sandi Willows-Munro, UKZN; Dr Danuta Plisko, KZN Museum; Dr John Measey (CIB); Dr Sarah Davies (CIB), and others (Wilson)

Restoration of Natural Capital. Collaborator: Dr David Le Maitre. CSIR, Environmentek, PO Box 320, Stellenbosch 7599 (Esler)

Restoration of Natural Capital. Collaborator: Prof. James Blignaut. ASSET, Jabenzi, Beatus & Department of Economics, University of Pretoria (Esler)

Restoration of Natural Capital. Collaborator: Prof. Sue Milton. RENU KAROO, Prince Albert (Esler)

Review of Ecological research and conservation management in the Cape Floristic Region between 1945 and 2015. Prof. Jane Carruthers, UNISA; Prof. Richard M. Cowling, NMMU, Ms Aurelia T. Forsyth, Ms Genevieve Pence and Mr Guy Palmer, CapeNature; Prof. M. Timm Hoffman, UCT; Dr Frederick J. Kruger, Free State University; Prof. Guy F. Midgley, SU and Prof. David M.

Richardson, SU; Prof. John R. Wilson and Domitilla C. Raimondo, SANBI; Dr Nicola J. van Wilgen, SANParks (van Wilgen)

River Rehabilitation: Mr Dean Impson, CapeNature; Dr Martine Jordaan, CapeNature; Ms Jeanne Gouws, Cape Nature; Dr Darragh Woodford, WITS University; and Dr Brian Finlayson, California Fish and Game, USA (Weyl)

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

Scientometrics of WfW literature. Collaborator: Dr Nadia Sitas. CSIR, Stellenbosch (Esler)

Seed bank dynamics in invasive plants. Collaborator: Prof. Petr Pyšek, Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice, and Charles University in Prague, Czech Republic (Le Roux)

SESYNC Collaboration, title: Anticipatory governance and societal feedbacks in socio-environmental transitions: multi-continental acacia invasions as a model system, Collaborators: Dr Christoph Kueffer, Institute of Integrative Biology & TdLab, D-USYS, ETH Zurich, Professor for urban ecology, HSR Rapperswil and Dr Joana Vincente, based at the Research Centre in Biodiversity and Genetic Resources (CIBIO) at the University of Évora (Portugal) (Gaertner)

Small carnivores in space and time, 2012-2015: Dr Emmanual do Linh San, University of Fort Hare; Prof. Jerry Balant, Mississippi State University, USA; Dr Jun Sato, Fukuyama University, Japan (Somers)

Small mammal ecology. Collaborator: Prof. Ara Monadjem, Department of Biological Sciences, University of Swaziland (Chimimba)

Status of plant invasions in protected areas. Collaborators: Prof. Petr Pyšek, Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice, and Charles University in Prague, Czech Republic; Dr Piero Genovesi, ISPRA, Institute for Environmental Protection and Research, and Chair IUCN SSC Invasive Species Specialist Group, Italy; and Prof. Richardson, Centre for Invasion Biology, Stellenbosch University (Foxcroft)

Tarantula Risk Assessment: Prof. M Robertson, Mr Cavin Shivambu, Department of Zoology and Entomology, University of Pretoria, South Africa (Foord)

The ecology of plant invasions. Collaborator: Prof. Petr Pyšek, Institute of Botany, Academy of Sciences of the Czech Republic (Richardson)

The role of mutualisms in plant invasions. Collaborator: Prof. Anna Traveset, Institut Mediterrani d'Estudis Avançats, Balearic Islands, Spain (Richardson)

The role of species traits in plant invasiveness. Collaborator: Prof. Michelle Leishman, Department of Biological Sciences, Macquarie University, NSW, Australia (Richardson)

Thermotolerance in explaining invasiveness in plants. Collaborator: Prof. Petr Pyšek, Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice, and Charles University in Prague, Czech Republic (Le Roux)

Trophic subsidies in aquatic ecosystems: Prof. James Vonesh, Virginia Commonwealth University; Dr Mike McCoy University of east Carolina, USA; Prof. Cang Hui, Stellenbosch University; Dr John Measey, Center for Invasion Biology; Dr Michelle Jackson, University of Pretoria; Prof. Martin Villet, Rhodes University; Dr Darragh Woodford, WITS University; Dr Ryan Wassermann, SAIAB (Weyl)

Urban invasions working group: Collaborators: Dr Mathieu Rouget, University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Durban, KwaZulu-Natal, South Africa, Mr Errol Douwes, EThekwini Municipality, Durban, Prof. John Wilson, South African National Biodiversity Institute (SANBI) & Centre for Invasion Biology (CIB), Ms Ulrike Irlich, Green Jobs Unit, City of Cape Town, Environmental Resource Management Department (ERMD), Westlake Conservation Office, Ou Kaapse Weg, Cape Town, South Africa (Gaertner)

Urban Invasions. Collaborators: Mr Philip Ivey (SANBI), Ms Louise Stafford and Ms Ulrich Irlich (City of Cape Town); Mr Errol Douwes (EThekwini Municipality) (Gaertner, Rouget)

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

Woody weed invasions in East Africa. Collaborators: Dr Urs Schaffner (CABI Switzerland) and Dr Arne Witt (CABI Africa) (van Wilgen).

A. 4. Information brokerage

A. 4.1 Popular articles and talks

Articles

Alexander, M.E. 2015. Disruptive interactions predatory-prey relationships in invasions. *Quest* 11(2), pp. 14-16.

Anonymous. 2015. A career in invasion science. *Quest* 11(2), pp. 57.

Anonymous. 2015. Fishing for invasive species. *Quest* 11(2), pp. 21.

Anonymous. 2015. From forestry to invasion science. *Quest* 11(2), pp. 51.

Anonymous. 2015. From insects to invasion science. *Quest* 11(2), pp. 57.

Anonymous. 2015. From mathematics to invasion science. *Quest* 11(2), pp. 59.

Anonymous. 2015. Grasslands of Lesotho helped to inspire career in invasion science. *Quest* 11(2), pp. 16.

Anonymous. 2015. Iimbovane learner begins her future in science. *Quest* 11(2), pp. 13.

Anonymous. 2015. Introducing invasive plants for biofuel: weighing up the pros and cons. *Quest* 11(2), pp. 21.

Anonymous. 2015. Monitoring invasive species from icy islands to arid lands. *Quest* 11(2), pp. 17.

Anonymous. 2015. The low-down on invasion science. *Quest* 11(2), pp. 3-4.

Clusella-Trullas, S., Logan, M. & Minnaar, I.A. 2015. Ladybirds: successful invaders in small packages. *Quest* 11(2), pp. 8-10.

Du Plessis, D. & Turner, S. 2015. Getting the message across: the Iimbovane Outreach Project. *Quest* 11(2), pp. 42-43.

Gaertner, M., Irlich, U., Visser, V., Walker, G. & McLean, P. 2015. Cities invaded. *Quest* 11(2), pp. 48-50.

Hart, L. & Downs, C. 2015. Winged invaders: bird introductions. *Quest* 11(2), pp. 38-41.

Johnson, S. 2015. Invasive species in pollination networks. *Quest* 11(2), pp. 30-33.

Kumschick, S. 2015. Risk assessment: a key tool for reducing the incidence and impacts if invasions. *Quest* 11(2), pp. 52-53.

Measey, G.J. & Davies, S.J. 2015. Hopping invaders. *Quest* 11(2), pp. 34-37.

Mostert, E., Gaertner, M., Hall, S., Mukundamago, M. & Holmes, P. 2015. Solving the puzzle of restoring the missing fynbos. *Quest* 11(3), pp. 32-35.

Mothapo, N. & Wossler, T. 2015. Ant invasions. *Quest* 11(2), pp. 27-29.

Novoa, A. & Shackleton, R. 2015. Stakeholder involvement: making strategies workable. *Quest* 11(2), pp. 54-56.

Richardson, D.M. 2015. Biological invasions and the emergence of invasion science. *Quest* 11(2), pp. 5-7.

Robinson, T. 2015. Marine invasions in South Africa: patterns and trends. *Quest* 11(2), pp. 44-45.

Rouget, M. 2015. Land-use planning and biological invasions. *Quest* 11(2), pp. 18-19.

Ruwanza, S. 2015. Who is using the water along the Berg River: alien or native plants? *Veld and Flora.* September 2015, pp. 130-132.

Van Wilgen, B.W. 2015. Natural fires and plant invaders – what is the link? *Quest* 11(2), pp. 22-23.

Vimercati, G. & Measey, G.J. 2015. Frog eat frog. *FrogLog*. April 2015, pp. 32-33.

Visser, V. & Canavan, S. 2015. Invasive grasses: Africa burns and why this matter for grasses. *Quest* 11(2), pp. 24-26.

Walker, G. & Irlich, U. 2015. Tree of Heaven – the backyard tree from hell. *Veld and Flora.* December 2015, pp. 63.

Weyl, O. 2015. Alien fish removals: a new beginning for the Rondegat River. *Quest* 11(2), pp. 11-12.

Wilson, J.R. & Davies, S.J. 2015. Managing invasions before they become widespread. *Quest* 11(2), pp. 46-47.

Talks

Esler, K.J. 2015. *Digging up the dirt – experimental insights into what controls the current and future distribution of Fynbos and Succulent Karoo vegetation.* Talk to the Indigenous Bulb Society of South Africa, Pinelands, July 2015.

Esler, K.J. 2015. *Connecting the knowing with the doing: Fynbos Ecology*. Wednesday Talks at Kirstenbosch, Cape Town, February 2015.

Hui, C. 2015. Unlocking patterns of nature – The marriage of mathematics and ecology. Inaugural Lecture, Stellenbosch University & SUN MEDIA, Stellenbosch.

Foxcroft, L.C. 2015. *The Kruger experience: problems & solutions to biological invasions*. South African Wildlife College, Skukuza.

Foxcroft, L.C. 2015. *Biological invasions in Kruger National Park. Organization for Tropical Studies Lecture Series*, Skukuza.

Foxcroft, L.C. 2015. *Biological invasions: status, threats and options*. Marlothii Conservancy, Marloth Park.

Measey, G.J. 2015. *Frogs of the Cape peninsula*. Cape Tourist Guide Association, Cape Town.

Measey, G.J. 2015. *Conservation of Table Mountain National Park's frogs*. SANParks Junior Rangers, Cape Town.

Weyl, O.L.F. 2015. *Freshwater Fish Conservation*. SANParks, Skukuza, Kruger National Park.

Weyl, O.L.F. 2015. *Production and economic potential of inland fisheries.* WRC Dialogue on findings of the "Baseline and scoping study on freshwater inland fisheries". University of Western Cape, Bellville.

Weyl, O.L.F. 2015. *Australian red-claw crayfish, Cherax quadricarinatus, an emerging invader in South Africa*. SANBI Crayfish Workshop, Botanical Gardens Pretoria.

Weyl, O.L.F. 2015. *Managing alien fishes in South Africa*. Rhodes University, Grahamstown.

Weyl, O.L.F. 2015. *Using multiple information sources to make sense of fish invasions*. Rhodes University, Grahamstown.

Weyl, O.L.F. 2015. *The trouble with alien sport fishes*. Stellenbosch University, Stellenbosch.

Weyl, O.L.F. 2015. *Fish, conservation and management in North America: experiences from a recent trip to Canada and the USA*. SAIAB/DIFS Seminar.

Wilson, J.R. 2015. *Biological invasions in South Africa: what are we supposed to do, and what should we do*? Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, 24 August.

A. 4.2 Media interactions

Newspaper articles

Anoniem. 2015. Die paddatjie kan by enige vlei gaan opsit. *Eikestadnuus,* 26 March 2015.

Anonymous. 2015. Frogs have made their own trek across the country. *The Witness,* 21 May 2015.

Anonymous. 2015. Harold Porter introduces young minds to careers in Biodiversity. *Overstrand Herald,* 13 August 2015.

Brits, E. 2015. Paddas verorber mekaar graag. *Burger (Kaap Platteland),* 16 September 2015.

Cowell, C., Adams, T. & Tyagana, N. 2015. Rehabilitation in Tokai aims to restore biodiversity components. *SANParks Times,* 1 December 2015.

De Klerk, R. 2015 Marine wolf in sheep's clothing. *SANParks Times*, September 2016.

De Klerk, R. 2015. Trouble lurks under the surface of the Langebaan Lagoon. *SANParks Times,* 1 December 2015.

Richardson, D. 2015. Invasive species threaten our national biodiversity. *Cape Argus,* 28 July 2015.

Viljoen, M. 2015. Top conservation minds to focus on preserving the Cape Floral Kingdom. *Cape Times,* 10 April 2015.

Watkins, K. 2015. Waging war on weeds. *Constantiaberg Bulletin,* 21 May 2015.

Articles published by Stellenbosch University

Esler, K.J. 2015. Book shares know-how about fynbos region. *Research at Stellenbosch University: showcasing research excellence 2015*.

Kumschick, S. 2015. Quantifying the impacts of alien species. *Research at Stellenbosch University: showcasing research excellence 2014.*

Electronic sources

Anonymous, 2015. Alien plants spreading across the world causing billions in damage, says study, The Guardian [online] 20 August 2015. Available at: <http://www.theguardian.com/environment/2015/aug/20/alien-plants-spreading-across-the-world-causing-billions-in-damage-says-study>

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Anonymous, 2015. Invasive plants pose billion-dollar threat to economies around the world, The Japanese Times [online] 20 August 2015. Available at: < http://www.japantimes.co.jp/news/2015/08/20/world/science-health-world/invasive-plants-pose-billion-dollar-threat-economies-around-world/>

Anonymous, 2015. Lantana wondering, Der Tagesspiegel [online] 20 August 2015. Available at: < http://www.tagesspiegel.de/wissen/invasive-pflanzen-wandelroeschen-auf-wanderschaft/12208370.html>

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Fourie-Basson, W. 2015. Kirstenbosch a time bomb waiting to burn, warns ecologist, SU News [online] 8 May 2015. Available at: <http://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=2517>

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Radio and television

Measey, G.J. Interview on RSG (Monitor) about research conducted on the diets of frogs, September 2015.

Van Wilgen, B.W. Interview on Channel Africa (Africa Rise and Shine), Colloquium on conservation of natural vegetation, April 2015.

Van Wilgen, B.W. Interview on MFM, The effect of fires on the Jonkershoek Fynbos, March 2015.

Van Wilgen, B.W. Interview on WitsRadio, the Cape Fires, March 2015.

A. 5. Service provision

A. 5.1 International panels and committees

13th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI 2015). Hawaii, 20–24 September. International Scientific Committee: Member (Richardson, Wilson)
American Fisheries Society, International Fisheries Section Advisory Board member (Weyl)
COST Action TD1209 "Alien Challenge": MC Observer (Kumschick)
Future Earth, bioDISCOVERY Core Project, Scientific Committee member (Weyl)
Green Trust, Member, Board of Trustees (Chimimba)
International Plant Sentinel Network: International Advisory Group Member (Wilson)
IUCN Mediterranean-Type Ecosystem Thematic Group: Member (Esler)
IUCN Species Survival Commission (SSC) - Crocodile Specialist Group: Member (Downs)
IUCN SSC- Freshwater Fish Specialist Group, Regional Chair Southern Africa (Weyl)
IUCN SSC- Invasive Species Specialist Group: Member (Foxcroft, Kumschick, Richardson, van Wilgen, Wilson)
IUCN SSC- Southern African Amphibian Group: Chair (Measey)
IUCN SSC- Stork, Ibis and Spoonbill Specialist Group: Member (Downs)
IUCN-SSC- Otter Specialist Group: Member and Southern African Coordinator (Somers)
IUCN-SSC- Re-introduction specialist Group: Member (Somers)
IUCN-SSC- Wild Pig Specialist Group: Member (Somers)
MEDECOS Association, Executive committee of ISOMED: National Representative (Esler)
Mediterranean Research Managers International Cooperative: Member (Esler)
National Science and Technology Forum (NSTF), Vice-Chair of Adjudication Panel (Chimimba).
South African National Biodiversity Institute, Advisory Board Member (Research Committee) (Chimimba)
Southern African Plant Invaders Atlas: Advisory Board member (Robertson)
Symposium on insect responses to climate change, International Congress of Entomology 2016, Florida, USA: Member, Organizing Committee (Terblanche)

A. 5.2 National panels and committees

Academy for Environmental Leadership: Programme Advisor (Esler)
Berg River Clearing and Rehabilitation Advisory Committee: Member/Technical Advisor (Esler, Gaertner)
C.A.P.E. Invasive Alien Animal Working Group South Africa: Member (Davies, Kumschick, Measey, Wilson)
Department of Environmental Affairs Natural Resource Management: Research Advisory Panel member (Richardson, van Wilgen, Wilson)
Flower Valley Conservation Trust Sustainable Harvesting Programme Research Working Group: Member (Esler, Gaertner)
Fynbos Forum Committee: Member (Esler)

HERS Advisory Board: Chair (Esler)
IUCN Wild Dog Advisory Group of South Africa: Member (Somers)
National Invasive Animal Forum: Member (Kumschick)
Royal Society of South Africa (Council member & Vice President) (Richardson)
SAEON Fynbos Node Liaison committee: Member (Esler)
South African Data Centre for Oceanography: Board member (Griffiths)
South African National Biodiversity Institute: Genetic Monitoring Group panel member (Le Roux)
South African National Biodiversity Institute: Board member (van Wilgen)
South African National Invasive Alien Animal Forum: Member (Wilson)
WRC 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)
Department of Forestry, Fisheries and Aquaculture, Research and Technology Fund - Project proposal reviews (Robinson).

A. 5.3 Editorial and refereeing activities

Editor

African Journal of Herpetology (Measey)
African Journal of Wildlife Research (Guest Editor for Special Carnivore Issue) (Somers)
BioInvasions Records (Wilson)
Biological Invasions (Special Issue Co-guest editor) (Clusella-Trullas, Richardson, Terblanche)
Diversity and Distributions (Editor-in-Chief) (Richardson)
Journal of Thermal Biology (Special Issue Guest editor) (Terblanche)
Koedoe (Foxcroft)

Associate Editor

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

Salamandra (Measey)
South African Journal of Science (van Wilgen)

Editorial Boards

African Entomology (Terblanche)
African Natural History (Griffiths)
Animals (Griffiths)
AoB Plants (Richardson)
Austral Ecology (Clusella-Trullas)
Austral Entomology (Terblanche)
BMC Ecology (Hui)
Conservation Biology (Cambridge University Press book series) (Richardson)
Ecology, Biodiversity, and Conservation (Cambridge University Press book series) (Richardson)
Forest Ecosystems (Richardson)
Frontiers in Ecology and Evolution (Hui)
Frontiers in Invertebrate Physiology (Clusella-Trullas)
Journal of Thermal Biology (Clusella-Trullas, Terblanche)
Koedoe (Griffiths)
Ostrich (Downs)
World Registry of Invasive Marine Species, Thematic editor (Robinson)

Reviewing

National

African Biodiversity & Conservation; *African Journal of Aquatic Science*; *African Journal of Marine Science*; *African Journal of Wildlife Research*; *African Zoology*; *Bothalia*; *Ostrich*; *South African Journal of Botany*; *South African Journal of Science*; *Koedoe* (incl. Special Issue on 'African Protected Area Conservation and Science'); *South African Journal of Botany*; *Transactions of the Royal Society of South Africa*

International

Acta Biotheoretica; *Acta Oecologia*; *Acta Zoologica Cracoviensia*; *African Journal of Marine Science*; *American Naturalist*; *Amphibia-Reptilia*; *Anais da Academia Brasileira de Ciências*; *Animal Conservation*; *AoB Plants*; *Arachnologische Mitteilungen*; *Auk Ornithological Advances*; *Biological Conservation*; *Biological Invasions*; *Biology Letters*; *Bioscience*; *Biological Conservation*; *Biotropica*; *Bird Conservation*; *Botany*; *Bulletin of Entomological Research*; *Bulletin of Marine Science*; *Comparative Biochemistry and Physiology A*; *Condor*; *Conservation Biology*; *Conservation Letters*; *Current Opinions in Insect Science*; *COSUST*; *Ecology and Evolution*; *Environmental Biology of Fishes*; *Environmental Monitoring and Assessment*; *Environmental Science & Policy*; *Evolutionary Applications*; *Ecology Letters*; *Ecography*; *Ecology*; *Evolution*; *Forest Ecology & Management*; *Frontiers in Ecology and the Environment*; *Functional Ecology*; *Global Ecology and Biogeography*; *Hydrobiologia*; *International Journal of Biodiversity and Conservation*; *International Journal of Science Education*; *Journal of Applied Ecology*; *Journal of Applied Ichthyology*; *Journal of Arachnology*; *Journal of Arid*

Environments; *Journal of Applied Ecology*; *Journal of Biogeography*; *Journal of Ecology*; *Journal of Experimental Biology*; *Journal of Fish Biology, Fisheries Research*; *Journal of Great Lakes Research*; *Journal of Insect Physiology*; *Journal of Integrated Environmental Sciences*; *Journal of Shellfish Research*; *Journal of Zoology*; *Journal of Zoology, London*; *Koedoe*; *Landscape and Urban Planning*; *Limnologica*; *Mammalia*; *Mammal Research*; *Marine and Freshwater Research*; *Marine Environmental Research*; *Molecular Ecology*; *Natural History*; *Nature*; *Neobiota*; *New Phytologist*; *Oecologia*; *Peptides*; *Physiological and Biochemical Zoology*; *Plant Ecology & Diversity*; *Plos One*; *Preslia*; *Riparian Ecology and Conservation*; *Scientific Reports Nature*; *Scientific Reports Thermal Biology*; *Scientific Reports Zoology*; *Zoology and Ecology.*

Grant reviews for external bodies

Czech Science Foundation (Esler)
Deutsche Forschungsgemeinschaft (Richardson)
FONDECYT (Terblanche)
International Foundation for Science (Weyl)
National Geographic (Clusella-Trullas, Downs)
National Science Foundation (USA) (Downs)
National Research Foundation (van Wilgen)
Netherlands Organisation for Scientific Research (Wilson)
Swiss National Science Foundation (van Wilgen)
University of Wisconsin-Milwaukee's Research Growth Initiative (Weyl)
Water Research Commission (Esler)

Appointment reviews and committees

Rhodes University, South Africa: Honorary Professorial Appointment (Weyl)
Royal Society of New Zealand (Marsden Fund), Prime Minister's Science Prize (Referee) (Richardson)
University of Denver, USA (Professorial Appointment) (Richardson)
University of Exeter, UK (Professorial Appointment) (Richardson)
University of Massachusetts Amherst, USA (Tenure Assessment) (Richardson)
University of Minnesota, USA (Professorial Appointment) (Richardson)
University of Nottingham, UK (Professorial Appointment) (Richardson)
University of Southampton, UK (Professorial Appointment) (Richardson)
University of Toronto Scarborough, Canada (Assistant Professorial Appointment) (Weyl)
University of Venda (Lecturer appointment) (Somers)

A. 5.4 Consulting and other services rendered

Consultancy products

Herbst, M., Foxcroft, L.C., Le Roux, J.J., Bloomer, P. and Do Linh San, E. 2015. A Conservation Assessment of *Felis silvestris*. In: M.F. Child, E. Do Linh San, D. Raimondo, H. Davies-Mostert and L. Roxburgh (eds), The Red List of Mammals of South Africa, Swaziland and Lesotho. South

African National Biodiversity Institute and Endangered Wildlife Trust, South Africa. (Le Roux, Foxcroft).

Foxcroft, L.C., Zambatis, G., Zambatis, N., Hofmeyr, M., Petersen, T.A. and Khoza, E. (2015). Protocol for the management of ornamental alien plants and landscaping in all developed areas of the Kruger National Park. Reference Number:16/Pr-KNP. (Foxcroft).

Kruger National Park Conservation Management Department. (2015). Invasive Alien Plant Clearing Strategy: Kruger National Park: 2016-2017. (Foxcroft).

McGeoch, M. A., Squires, Z. & GEO BON (2015) An Essential Biodiversity Variable approach to monitoring biological invasions: Guide for countries. pp.13, Group On Earth Observations Biodiversity Observation Network Technical Series #2, http://invasionevs.com/wp-content/uploads/2015/2008/MonitoringBiologicalInvasions.TechnicalReport.pdf. (Wilson).

Jackson, L., Wilson, J., Kumschick, S. (2015). The prioritisation of invasive alien animal projects by the National Invasive Animal Forum: Recommendations. Prepared for the South African Department of Environmental Affairs, pp. 16. (Kumschick, Wilson)

Le Maitre, D. C., Forsyth, G. G., Wilson, J. R. (2015) Guidelines for the development of national species-based invasive alien management programmes: setting geographically differentiated goals. Report No. CSIR/NRE/ECOS/ER/2015/0030/A, Natural resources and the Environment, CSIR, Stellenbosch, pp. 51. (Wilson)

A. 5.5 NRF Service Provision

Rating and project proposal reviews

NRF Rating reviews:

- Clusella-Trullas (1)
- Esler (1)
- Measey (1)
- Robertson (1)
- Somers (1)
- Weyl (1)
- Wilson (1)

Focus Area reviews:

- Conservation and Management of Ecosystems and Biodiversity: project proposal reviews (6) (Downs)
- Education (2) (Downs)
- Conservation and Management of Ecosystems and Biodiversity: project proposal reviews (2) (Foord)
- ACEP Programme (1) (Griffiths)

Panel and committee service

Competitive Program for Rated and Unrated Researchers - Grant review panel: Plant Sciences (Le Roux).