DSI-NRF Centre of Excellence for Invasion Biology

# DSI-NRF Centre of Excellence for Invasion Biology

## Annual Report for 2022

Signed off by DVC, SteerCom 14 September 2023

Centre for Invasion Biology · Stellenbosch University

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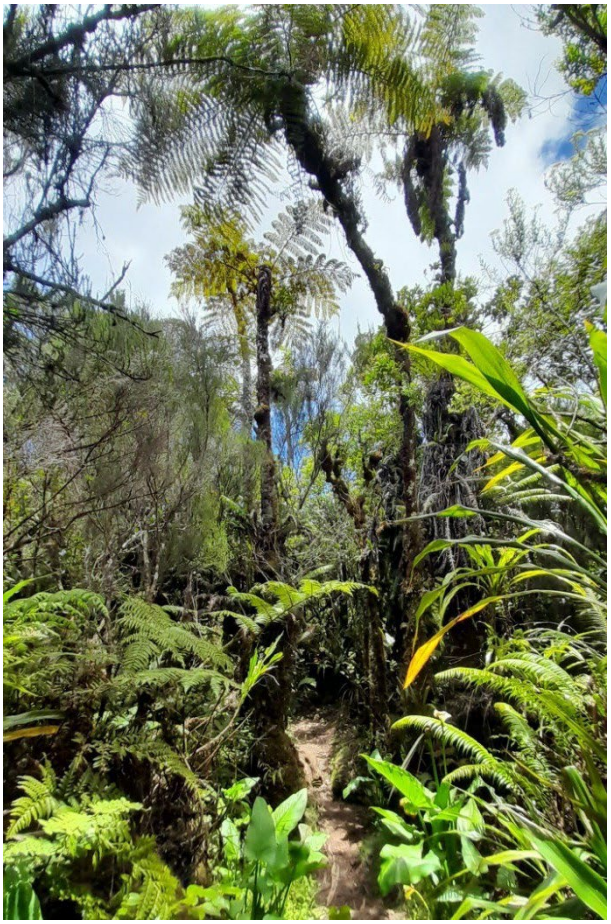
Sampling *Xenopus laevis* in Chile (Photo: J. Measey)



*Alien tree ferns, Réunion National Park (Photo: T. Robinson)*

*Alien plant surveys by Chair, Managing Biological Invasions in Protected Areas with Réunion National Park, CIRAD & SANParks staff (left) (Photo: T. Robinson)*

*Collecting seeds in remnant sand fynbos (above) (Photo: K. Esler)*

# AN APPRECIATION – DAVID LE MAITRE
# (15 May 1955 – 8 December 2022)

Prof. Brian van Wilgen expressed the loss of the C·I·B, CSIR, ecological and hydrological peer researchers as well as his own sorrow, when he wrote "*I was deeply saddened to receive the news that our colleague David Le Maitre (C·I·B Associate) had passed away after his three-year battle with cancer. I have known David since 1979, when he joined the staff of the Jonkershoek Forestry Research Centre as a research officer, after graduating with his forestry degree from Stellenbosch University. Over the next 40 years, we were colleagues, friends and close neighbours. David's initial research interests were in the effects of fire on fynbos ecosystems, and he went on to receive his MSc and PhD degrees in plant ecology at the University of Cape Town. With the demise of the South African Forestry Research Institute, we were all moved to the CSIR in 1990, where David remained until his retirement in 2017.*

*David was an unassuming scientist who made significant contributions in his field. Although his early career had a focus on fire ecology, David's most notable contributions came from switching his focus to the effects of vegetation cover on water resources. He played a leading role in the team that developed models to estimate the reductions of surface water runoff as a result of the invasion of catchments by alien trees. He went on to become one of the key scientists that provided support, based on these estimates and ongoing refinements, to the Working for Water Programme over the next 25 years. He also contributed substantially to the identification of Strategic Water Resource Areas in South Africa, both in terms of surface and groundwater. This understanding has formed the basis for prioritizing and managing the land to protect water resources, which in turn is vital in a dry country like South Africa.*

*His work on these topics over the past three decades has resulted in a rich contribution to the literature on water conservation in South Africa, and it will remain relevant for many years to come. Over his career, David has co-authored over 200 publications, including papers in peer-reviewed journals, scientific book chapters, and policy and management-relevant reports. His work has been cited over 13 000 times, with more than 20 papers attracting over 200 citations each. His h-score at the time of his passing was 54. In October this year, David's contributions were recognized with an Eco-Logic Gold Medal in the category for Water Conservation*".

Prof. Le Maitre's enthusiasm for working with students remained vibrant and he co-supervised and mentored many post-graduate students. He had hoped to be able to reprise his 2021 role evaluating student presentations at the 2022 C·I·B Annual Research Meeting as in 2021, which his health ultimately did not allow.

# EXECUTIVE SUMMARY

| | | |
|---|---|---|
| **Reporting period** | : | 1 January 2022 - 31 December 2022 |
| **Name of Acting Director** | : | Prof. Guy F. Midgley |
| **Name of CoE** | : | DSI-NRF Centre of Excellence for Invasion Biology |
| **Abbreviated CoE Name** | : | Centre for Invasion Biology (C·I·B) |
| **Host institution** | : | Stellenbosch University |

**Preamble**

Following staff losses and other challenges in 2021, 2022 provided new opportunities for the Centre for Invasion Biology (C·I·B) via alignment with Stellenbosch University's new School for Climate Studies (SCS). The Research Chair, Managing Invasive Species in Protected Areas made substantial progress through successful recruitment of promising young researchers, and the SCS-C·I·B continued to pursue other funding opportunities including another potential Chair to research invasive species introduced to harbours, ports, and marine areas via shipping and other vectors, and a new funding agreement was signed with SANBI relating to support for and capacity building in national reporting needs.

The receipt of the End-of-Funding Modalities Guide in early October and the lack of definition of transition date therein posed substantive challenges for planning the scope of remaining projects and appropriate funding allocations (with resulting impacts on planning and budgeting). This complicated the scheduling of transition activities, prioritization of projects and products, and especially the implied timing of reporting. Several areas of research and policy engagement were strongly maintained or re-invigorated in anticipation of the transition of this entity into its new form as a Type II entity hosted within the School for Climate Studies at Stellenbosch University, and this was reflected in the budget proposed for 2023.

Despite the assumption in the final NRF Service Level Agreement (SLA) of a reduction in deliverables, the C·I·B exceeded the majority of its 2022 targets. The C·I·B produced 105 peer-reviewed papers, four books and six book chapters. Of the papers, three had an impact factor (IF) ≥15 (where the SLA target was 2), 33 papers had an IF ≥4 (where the target was 10), 16 papers were led by or included a C·I·B Research Associate (RA) (where the target was 5-10). There was a tailing off in student numbers across the core team, as student funding allocations have clearly declined prior to the establishment of the Stellenbosch Type II entity that will maintain this extraordinarily productive and valuable collaborative team in a revised form.

*Progress against Key Performance Areas*

**1. Research**

Several of the C·I·B's 2022 research products appeared in high-impact journals, including *Trends in*

*Ecology & Evolution*, *Nature Ecology & Evolution* and *Science*, as well as *BioScience*, *Ecology Letters*, *Proceedings of the National Academy of Sciences of the USA*, *ISPRS Journal of Photogrammetry and Remote Sensing*, *Current Forestry Reports*, *PLOS Biology*, and *Scientific Reports*. Our research also featured prominently in the main journals specializing in biological invasions, namely *Biological Invasions* and *NeoBiota,* maintaining the same number of outputs in these key publications in 2022 as in 2021 (9 and 4 papers respectively).

The C·I·B's research contributions continued to range from basic to applied science in 2022. The weighting of the outputs on this range has shifted as our funding sources and their mandates have shifted. A strong emphasis in our project selection in recent years has been on themes related to SANBI and DEFF-priorities. Intake of more advanced post-graduate students capable of contributing to risk analyses and issues aligned to the Status Reports has resulted in more products under our research theme *Detection, elucidation and quantification of impacts outputs*. There has been a corresponding reduction in biodiversity foundations outputs that may be associated with those BSc or Honours students not yet with extensive invasion biology experience and training.

## 2. Education and Training

The C·I·B supported 41 students (where the SLA target was 10), of whom 4 MSc students completed in 2022 (SLA target was 2), 8 PhDs completed (target was 0). In some cases, dissertation defense &/or graduation ceremonies remain to be done in 2023. Increasingly, the leveraging of non-NRF funding means that fewer of our students were wholly or partially funded from the C·I·B core grant (or even as free-standing NRF bursars). The Research Chair, Managing Biological Invasions in Protected Areas, is showing great initiative in complementary funding of students, also serving to secure co-supervision and mentoring from C·I·B Research Associates and peer researchers in provincial, national and overseas parks and protected areas. Our graduates continue to be sought for their solid training and canny insight, with one recent PhD taking up a lecturing role at University of KwaZulu-Natal even before his graduation was complete.

## 3. Networking

2022 witnessed increasing activities and interactions after Covid19 restrictions and residual impacts. Our 2022 Annual Research Meeting (ARM) was a hybrid conference. The value of online access was retained, however, as distant C·I·B alumni, Research Associates and international colleagues were able to watch the C·I·B current students present their work on a broad range of topics from biocontrol and climate adaptation to invasions management implications and emerging technologies.

## 4. Information Brokerage and Outreach

The C·I·B's Iimbovane team continued their successful outreach in 2022, conducting 46 school-based lessons at partner schools on anatomical and environmental scientific theory as well as practical fieldwork to enable learners to apply the theory in a hands-on manner designed to build technical and analytical skills. Iimbovane trained a total of 1124 high-school learners and 165 educators in 2022.

**5. Service Provision**

The C·I·B continued its involvement with the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), the South African National Status Report and ASRARP (Alien Species Risk Analysis Review Panel, a panel of experts coordinated by the South African National Biodiversity Institute [SANBI]), the Chair and considerable expertise constituting the EICAT board, and panel evaluations, journal editing.

**Transformation**

The C·I·B has continued to address transformation in biological sciences' research since its founding. Recruitment and retention focuses on increasing women's representation in the STEM disciplines (while the cross-disciplinary nature of biological invasion studies also invites contribution from social sciences, journalism, law and other areas mapping onto the diverse areas of South African society impacted by invasive alien species). The C·I·B has regularly refocused its aim to recognize national demographics, and encourage broader participation among HDI students and affiliates. The Centre has also been very successful in throughput and retention of black emerging researchers, retaining the expertise of alumni as Core team members, supervisors and co-supervisors, C·I·B management and advisors.

In 2022, the C·I·B exceeded its target for female students and post-docs (61% actual vs 55% target) but did not achieve its target for black students (51.2% actual vs 90% target). It should be noted that this latter target rose 10% in the C·I·B's final CoE stage, at a time that NRF support reduced 25%/pa and the NRF disallowed new students whose study period would exceed the CoE period- only 9.5% of C·I·B students were NRF-funded.

**Red Flags (and opportunities)**

Securing funding to ensure that the C·I·B's existence after 2023, and identifying structures continued to be the top priority in 2022. The C·I·B's natural synergy with Stellenbosch University's School for Climate Studies (SCS), given the impacts of climate change on invasive species, proceeds apace, and is scheduled to be finalized by the assumed date of dissolution of the current CoE on 15th September 2023.

Former C·I·B Director Prof. Richardson noted in the 2021 Annual Report that a crucial part of the success of the C·I·B was the "glue" funding that facilitated the development and effective functioning of the C·I·B networks (notably the core team and research associates) that were the means of achieving most of its aims. Finding such "glue money" remains challenging (e.g., to fund support staff, especially when some funders do not grasp that programmes and functions are delivered *by these staff*, without whom these output areas would necessarily discontinue). The new structure wherein the C·I·B is a key pillar of Stellenbosch University's School for Climate Studies is a "win-win", growing the latter with the former's experience and skills, harnessing the networks and synergizing new research, building on common ecological and earth science foci.

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# 1 RESEARCH

*What was the gender impact of the C·I·B's work?*
Women are well represented on the C·I·B's core team (24%), associates (43%), on the Stellenbosch hub staff (100%), the Iimbovane team (100%), post-docs (57%) and students (61%).

## *1.1 Objectives*

Research at the C·I·B aims to reduce the rates and biodiversity impacts of biological invasions by understanding how these can be reduced and remediated through appropriate policy interventions. C·I·B research also explores how interactions among global change drivers, especially climate change and biological invasions, potentially influence the impacts of biological invasions.

Our projects and integrated programmes of research address all aspects of the phenomenon of biological invasions, all taxonomic groups and all ecosystems, with a strong focus on South Africa. A better understanding of invasion patterns and processes is required, and options for management and remediation need to be explored in multiple ways. Each stage in the invasion process (pre-introduction; initial incursion; expansion; and dominance) demands special tools, insights and types of study. The C·I·B is at the forefront of such developments nationally and has been a major player in the field of invasion science internationally.

In addition to these aspects above, the C·I·B undertakes work under several over-arching themes: biological foundations, model systems, human dimensions, basic inventories, modelling capacities, policy formulation and risk assessment. These themes initially attract students from diverse biological fields (from fundamental to applied) and many other disciplines who then can contribute to cutting-edge invasion science research.

The C·I·B's 2022 research products included 105 papers in peer-reviewed journals, four chapters in edited books, and 6 scientific books. Several outputs appeared in high-impact journals, including *Trends in Ecology & Evolution*, *Nature Ecology & Evolution* and *Science*, as well as *BioScience*, *Ecology Letters*, *Proceedings of the National Academy of Sciences of the USA*, *ISPRS Journal of Photogrammetry and Remote Sensing*, *Current Forestry Reports*, *PLOS Biology*, and *Scientific Reports*. Our research also featured prominently in the main journals specializing in biological invasions, namely *Biological Invasions* and *NeoBiota,* maintaining the same number of outputs in these key publications in 2022 as in 2021 (9 and 4 papers respectively).

## *1.2 Progress*

### *Long-term projects*

The C·I·B was able to resume work on long-term projects in 2022, namely the Cederberg and Sani Pass long-term transects via C·I·B Research Associate Dr Charlene Janion-Scheepers and C·I·B Core Team Member Prof. Mark Robertson, respectively. The Soutpansberg gradient was active until 2021, but not used in 2022 per C·I·B Core Team Member and Chair, Vhembe Biosphere Reserve Prof. Stefan Foord.

### *Short-term projects*

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. Further details of many research projects are available on the C·I·B's web site (http://academic.sun.ac.za/cib/). Those projects reported below are exemplars but not exhaustive of the broad range of the C·I·B's research and the disciplines, taxa, spatial and temporal scales, and scientific approaches thereof.

#### *1.2.1 Biodiversity foundations – baseline data for pre-invasion states and comparisons*

The C·I·B has acknowledged that biology and the social sciences form the foundation for the study of invasion biology from its founding in 2004, where the impact of human activities such as agriculture and trade must be distinguished from natural processes including the natural movements of species. In addition to such foundational biology and biodiversity research helping to inform invasions research, it has also served to attract students and peer researchers to interdisciplinary collaborations, and possibly foster an interest in biological invasions themselves.

*Bio-informatics – key to conservation*

A range of high-resolution maps depicting the local diversity of tree species across the globe, as well as the environmental drivers of this diversity, will serve as a benchmark for the future management of forest ecosystems under a changing climate.

The maps, published in the journal *Nature Ecology and Evolution* recently, are based on 1.3 million sample plots and 55 million trees archived in the Global Forest Biodiversity Initiative database. It took 249 researchers from 50 countries two years to compile and standardise the database, with one-third of them based in traditionally underrepresented regions such as Africa and South America.

The main findings from the study are:

- There are on average 98 species per hectare at the equator. The number of species then decline until it becomes stable at about four species per hectare at both 50 degrees north and south of the equator.

- Temperature and precipitation are, however, not the only drivers behind local species richness and biodiversity patterns across latitudes. In tropical regions, factors such as landforms, soil and human impact also control species richness. In Africa, human influences such as selective timber extraction and fuelwood collection, together with large-scale degradation, are affecting local tree species richness.
- The most diverse tropical forests on Earth are in Amazonia, with more than 200 tree species per hectare.
- The most diverse temperate forests are in south-central Chile with up to 50 species per hectare.

Prof. Cang Hui, a biomathematician from Stellenbosch University (SU), C·I·B Core Team Member and senior author on the paper, says biodiversity databases such as forest inventories will continue to expand, as sample coverage in developing countries improve rapidly with integrated informatics platforms.

"*Although modelling can help address this gap, there needs to be a shared responsibility among conservation stakeholders at various levels of government, scientists, indigenous communities and other biodiversity monitoring groups to improve sample coverage of forest inventories in developing countries*," he said.

"*This should include the education and training of a new generation of biodiversity data scientists, ecologists and taxonomists to address this gap in the Global South and simultaneously create employment opportunities*," he added.

Read the paper:
Liang, J. et al. (2022). Co-limitation toward lower latitudes shapes global forest diversity gradients. *Nature Ecology & Evolution* 6, 1423-1437. https://doi.org/10.1038/s41559-022-01831-x

*Context matters in biological invasions*

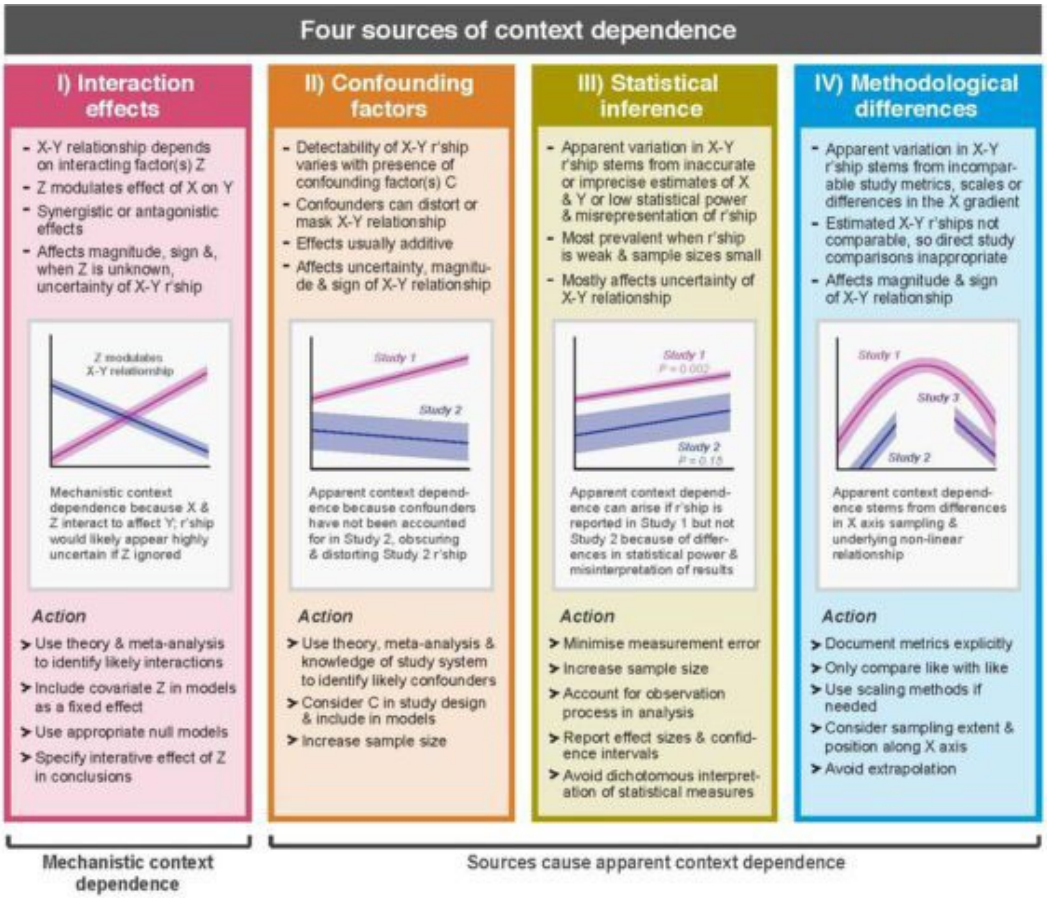
Whether an organism will become invasive and have impacts depends on how organisms were moved around, the type of organism, and the recipient environment (Pyšek et al. 2020). Or to put another way, if asked whether an organism is likely to become a harmful invader, ecologists are likely to answer '*Well… it depends.*' This reflects the wonderful variety and complexity of nature and people, but such a response can be enormously frustrating to policy makers and managers. They want a clear answer to the question '*What should we do?*'

A new synthesis paper in *Trends in Ecology and Evolution* (TREE) with an impact factor (IF) of ~20.589, co-authored by C·I·B Core Team Member Prof. John Wilson and C·I·B Research Associate Prof. Petr Pyšek, provides advice as to how this can be answered in a scientifically robust way, '*…it depends on how the data were collected and interpreted and on these specific factors…*'

The importance of context has been long debated in invasion science, and increasingly the term '*context dependent*' has been used as a shorthand for either '*We do not know*' or '*We have shown a factor to be important, but we recognise it is a bit more complicated than that*'.

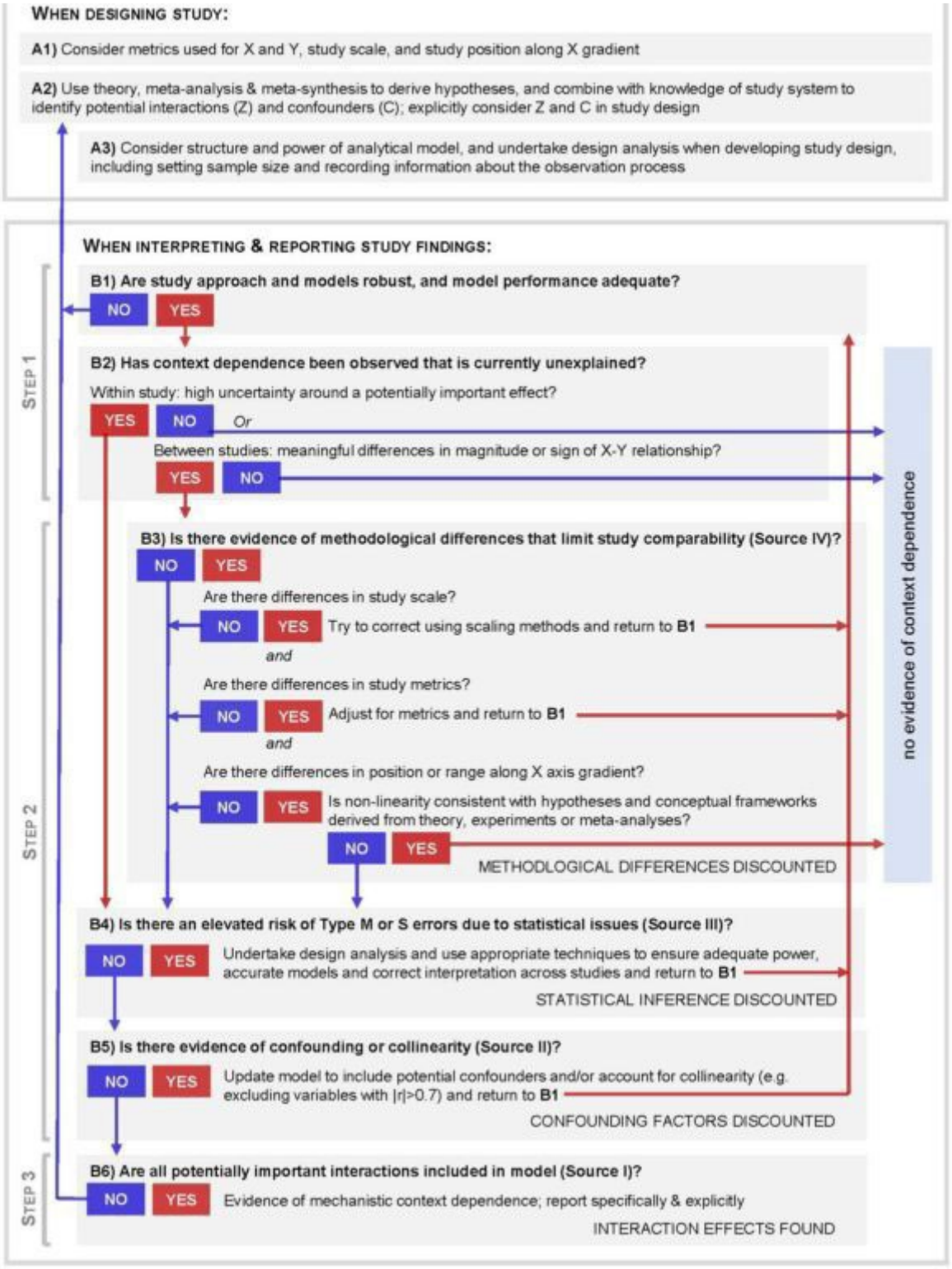
In their TREE paper, the authors identified four different reasons why the results of a study vary with the context under which the study is performed.

- There is an **interaction effect**. This means there is a mechanistic interaction between a variable and the invasive organisms. They cite the case of giant bamboo, *Phyllostachys bambusoides*, an example cited in their TREE paper. Invasive populations in Japan show a positive relationship with canopy cover in cold regions but a negative relationship in warm regions, owing to the interaction effects of light and temperature on bamboo occupancy (see Spake et al. 2021).
- There is a **confounding factor**. While it might appear from the data that there is a direct causal relationship, this is actually mediated by another (often unmeasured) factor. Therefore, if results are extrapolated to a different region where the confounder is no longer the same, then the relationship might not hold, and advice to managers will be misleading.
- How the relationship is defined also depends on the **statistical tools** used. Importantly this can both be due to overestimating the significance of a weak relationship and underestimating the potential importance of a relationship that is found to be 'not significant'.
- Finally apparent context dependence can occur if **different methods** are used, and this is not properly addressed when different studies are compared.




The paper elucidates each of these types of context dependence and proposes a flow diagram (see below) to assist in differentiating the different types and identifying what needs to be done to be confident that X really does depend on Y in a predictable way.

It will not be possible to always address context dependence, but it is fundamental to invasion science. *"If you aren't addressing context dependency you aren't doing ecology!" (Prof. Luke Flory, University of Florida on Twitter [https://mobile.twitter.com/lflory/status/1455638192363761664)](https://mobile.twitter.com/lflory/status/1455638192363761664)*




Read the full paper:
Catford JA, Wilson JRU, Pyšek P, Hulme PE, Duncan RP (2022) Addressing context dependence in ecology. *Trends in Ecology & Evolution*. [doi: 10.1016/j.tree.2021.09.007](doi: 10.1016/j.tree.2021.09.007)

### *1.2.2 Model groups and systems for understanding invasions and their impacts*

*Reptiles and amphibians display a high diversity of ageing rates*

If you want to study senescence then there are a lot of ways that you can go about doing this, but the best way by far is to know how long your study organisms live in the wild. In the paper by Reinke et al they used capture mark recapture to compare the ages of 77 species of reptiles and amphibians- the size of this data set is unprecedented in the literature. It required tight collaboration among over 400 authors that compiled the capture mark recapture data separately on every continent of the world (except Antarctica).

C·I·B Core Team Member John Measey and student André de Villiers compiled capture mark recapture data on the Cape Platanna, *Xenopus gilli*, over a period of 7 years starting when André started his MSc in 2014. The data comprised the only contribution of a long-term capture mark recapture data set on the southern African subcontinent. Their long-term data suggests that these animals do not live very long in the wild although they can live 20 years or more in the laboratory.

The study contributed to the findings that reptiles and amphibians display a high diversity of ageing rates when compared with previously published data on birds and mammals. The kings of ageing in this world are unsurprisingly the tortoises and turtles, but other species with protective armour were also found to have high longevity. The resulting paper' s impact factor (IF) rate of ~63.714 suggests peer researchers agree on the value of such an extensive data set that represents species and ecosystems globally.

Read the full paper:
Diverse aging rates in ectothermic tetrapods provide insights for the evolution of aging and longevity. *Science* 376(6600), 1459–66. https://doi.org/10.1126/science.abm0151

## *Model taxonomic groups*

*Acacias as a model system for understanding invasions and impacts*

While invasive Australian *Acacia* species (wattles) have some commercial and other benefits, they also have considerable detrimental impacts including to ecosystem services. Intentional introductions (for dune stabilization among other uses) and inadvertent introductions (in and on imports, on the tides and via other mechanisms) of wattles in South Africa and more broadly provides a valuable natural experiment illustrating many key tenets of invasion science, and thus wattles have long been a recurring focus of C·I·B research. Serving as one of the C·I·B's model taxa to identify foundational rules of invasion biology, researchers and successive students have contributed to the local and global body of knowledge on this taxon.

*Australian wattles around the world*

While this imminent book will be reported on later as a 2023 product, it collates a huge amount of 2022 and earlier work on acacia, much of which was C·I·B-funded. Edited by C·I·B Core Team Member (and former Director) Prof. Dave Richardson with C·I·B Research Associate Jaco Le Roux and long-time collaborator Elizabete Marchante, 122 authors updated the current knowledge on acacia globally. Contributors included C·I·B Core Team Members Cang Hui, Sabrina Kumschick, Dave Richardson, Brian Van Wilgen and John Wilson, C·I·B Research Associates Jane Carruthers, Sjirk Geerts, Pat Holmes, Christophe Kueffer, the late David Le Maitre, Jaco Le Roux, and Petr Pyšek, and current and former C·I·B students post-docs Ashleigh Basel, Christophe Botella, Michelle Gibson, Stuart Hall, Cally Jansen, Jan-Hendrik Keet, Ana Novoa, James Rodger, Ross Shackleton and Rafael Zenni.

Collectively the authors looked at the historical and social aspects of acacia and its introduction outside its native ranges, the “Wattles” invasion syndrome, the taxonomy and phylogeny of the species pool, acacia macroecology, conservation and management in Australia, and invasion genetics and history elsewhere in the world.

*Xenopus laevis - A globally significant invasive amphibian*

*How a parasite can show us the movement of its frog host*

Genetic data from parasites can act as tags, revealing the translocation of their hosts. In a recent study by Anneke Lincoln Schoeman, former C·I·B-funded student, and co-authors demonstrated the widespread translocation of the African Clawed Frog across South Africa by using a flatworm parasite.

The African Clawed Frog, *Xenopus laevis*, is a globally invasive amphibian that is native to southern Africa. It has been moved around extensively globally and domestically due to its use as a model research animal and biological pregnancy test in the mid-1900s.

One of its parasites, *Protopolystoma xenopodis*, which lives in the bladder of the frog, has accompanied the African Clawed Frog to much of its invasive range. This parasite is very host-specific and has a direct life cycle, which means that its genetic differences between different parts of southern Africa will shed light on the genetic differences in the host. If these genetically-distinct parasites are found in areas where they do not historically belong, it can be assumed that it (and its host) has been moved.

For their study, Dr Schoeman and her co-authors used this frog-parasite system as a proof of concept that parasite phylogeography can give information on the mysterious movements of their hosts. To do this, Schoeman sampled frogs from different areas in southern Africa and from the species' invasive range in France and Portugal.

After performing phylogeographic analyses on the sampled frogs and their parasites, the authors found genetically distinct "southern" parasites on frogs in the north, indicating that some form of movement took place in the past. What makes this interesting is that, at the study's level of sampling, the frog's genetic make-up revealed nothing of this movement.

"*Parasites are often forgotten in invasion biology. Yet, on average, every free-living invader takes three parasite species along with it for the ride. Our study's findings are important as we can show future investigators how to go about to use parasites in invasion research for animals where sample size might be a problem*," says Dr Schoeman, lead author of the study published in the *Journal of Applied Ecology*. "*This was not a problem for a widespread study species like ours but can become an important consideration when you work with animals that are difficult to obtain or endangered*."

Read the full paper:

Schoeman, A.L., du Preez, L.H., Kmentoví , N. & Vanhove, M.P.M (2022). A monogenean parasite reveals the widespread translocation of the African Clawed Frog in its native range. *Journal of Applied Ecology*. https://doi.org/10.1111/1365-2664.14271

### *1.2.2.1. Model systems*

*Invasions in urban areas*

In addition to the C·I·B's participation in the Global Urban Biological Invasions Consortium (GUBIC; https://cubes- labs.com/gubic/), which provides a useful focus and benchmarking opportunities for our work on invasions in urban areas, the C·I·B researches a broad range of urban invasions:

*Mapping Johannesburg's urban forest*

A study by Prof. Solomon Newete and Dr Khaled Abutaleb from the Agricultural Research Council (ARC), in collaboration with C·I·B Core Team Member Prof. Marcus Byrne from the University of the Witwatersrand, will help the City of Johannesburg Metropolitan Municipality to address the disparity in the urban green structure between the City's poor and affluent suburbs.

Since the inception of planting street trees in France in 1850, mainly for their aesthetic value and as a symbol of modernity, they have been adopted as an integral part of urban planning and development in the contemporary world to serve beyond their traditional purpose. This includes reduction of urban pollution and the heat island effect, and the rising challenges of global warming. Many of the common street trees in European countries were also introduced into former colonies in Africa, the legacy of which is very much alive in South Africa.

The City of Johannesburg is reported to have the largest artificial forest in the world, with anecdotal reports estimating it to contain over 10 million trees. Some of the most prominent tree species in the city's streets include the common European Oak (*Quercus robur L*), London Plane (*Platanus × acerifolia Willd.*) and South American Jacaranda (*Jacaranda mimosif*olia), predominantly located in the most affluent suburbs of Johannesburg where the Europeans lived. As a result, many of the poor suburbs in the south such as the township of Soweto, as well as Alexandra in the northeast, do not have the benefits of street trees and parks. The City of Johannesburg Metropolitan Municipality plans to address this disparity in the urban green structure between the poor and affluent suburbs and therefore, mapping of street trees is of utmost importance for the metro to prioritize the future planting of trees to fill these gaps.

For their study, Prof. Newete and co-authors mapped the tree canopy cover (TCC) of the two most common street trees, Jacaranda and London Plane using multispectral SPOT 6 satellite imagery acquired from the South African National Space Agency (SANSA). The accuracy of mapping trees at the species level, however, depends on the spectral and spatial resolution of the available satellite imagery and the classification algorithms used.

The classification results showed an overall accuracy of 88%, indicating a vegetation cover of approximately 66% in the study area, of which Jacaranda and London Plane occupied 18.4% and 19.6%, respectively. This suggests that if these two common trees make up only 38% of the tree canopy, Johannesburg is undoubtedly one of the most diversely afforested cities in the world, should the TCC of all the other tree species found there be considered. Many of these trees were found to occur in the affluent suburbs in the north of the city. The township of Alexandra had by far the lowest street tree density in the study area and is, therefore, one of the city suburbs that requires a tree planting programme.

"*These findings would not only help to prioritize the increase of targeted vegetation cover in low cover areas, but it will also provide valuable information for the protection of vulnerable species such as London Plane from the threat of the polyphagous shot hole borer* (*Euwallacea fornicates*) *in Johannesburg*," says Prof. Newete, lead author of the study published as a *Scientific Report* in *Nature*.

He adds, "*The polyphagous shot hole borer is an alien bark beetle that can kill its host species, and due to the London Plane being one of the reproductive hosts of this beetle, the accurate mapping of these trees will facilitate with any future intervention measures*."

Read the full paper:

Newete, S.W., Abutaleb, K. & Byrne, M.J. Mapping the distribution and tree canopy cover of *Jacaranda mimosifolia* and *Platanus × acerifoli*a in Johannesburg's urban forest. *Scientific Report* 12, 5998 (2022). https://doi.org/10.1038/s41598-022-09780-y

## *1.3 Detection, elucidation and quantification of impacts and risk analysis*

Methods to detect and quantify biological invasions continue to be the C·I·B's central focus, as decreasing response time, a shared understanding of the metrics and potential impacts may control and/or reduce the impacts of these invasive species.

*Towards a framework for conceptualizing and managing invasive forest pathogens*

C·I·B collaborator Dr Trudy Paap, post-doctoral research fellow at Forestry and Agricultural Biotechnology Institute (FABI) at the University in Pretoria, advises that biological invasions are significant drivers of global environmental change and present a growing threat to biodiversity, ecosystem services, economies and human health. Invasive alien species are represented by organisms across all taxonomic groups however, invasion science has focused mostly on plants and animals. Microorganisms are relatively poorly represented in the invasion science literature, despite pathogenic microorganisms consistently being ranked amongst the most damaging invasive species.

In particular, invasive forest pathogens have led to disastrous disease epidemics, which have completely altered planted and urban forests and natural woody ecosystems (Figure 1). Well known examples include chestnut blight in the United States and Europe, ash die-back in Europe and Phytophthora die-back in southwest Australia.

A challenge to the discipline of invasion science has arisen in that researchers studying different taxonomic groups have developed distinct ways of investigating the phenomenon of biological invasions. Efforts have been made to reconcile these differences, notably in the proposed Unified Framework for Biological Invasions of Blackburn et al. (2011; *Trends in Ecology and Evolution* 26: 333-339 doi:10.1016/j.tree.2011.03.023). However, this framework was largely developed to merge definitions and processes for studying plant and animal invasions, and practical difficulties arise when applying the framework to microorganisms.

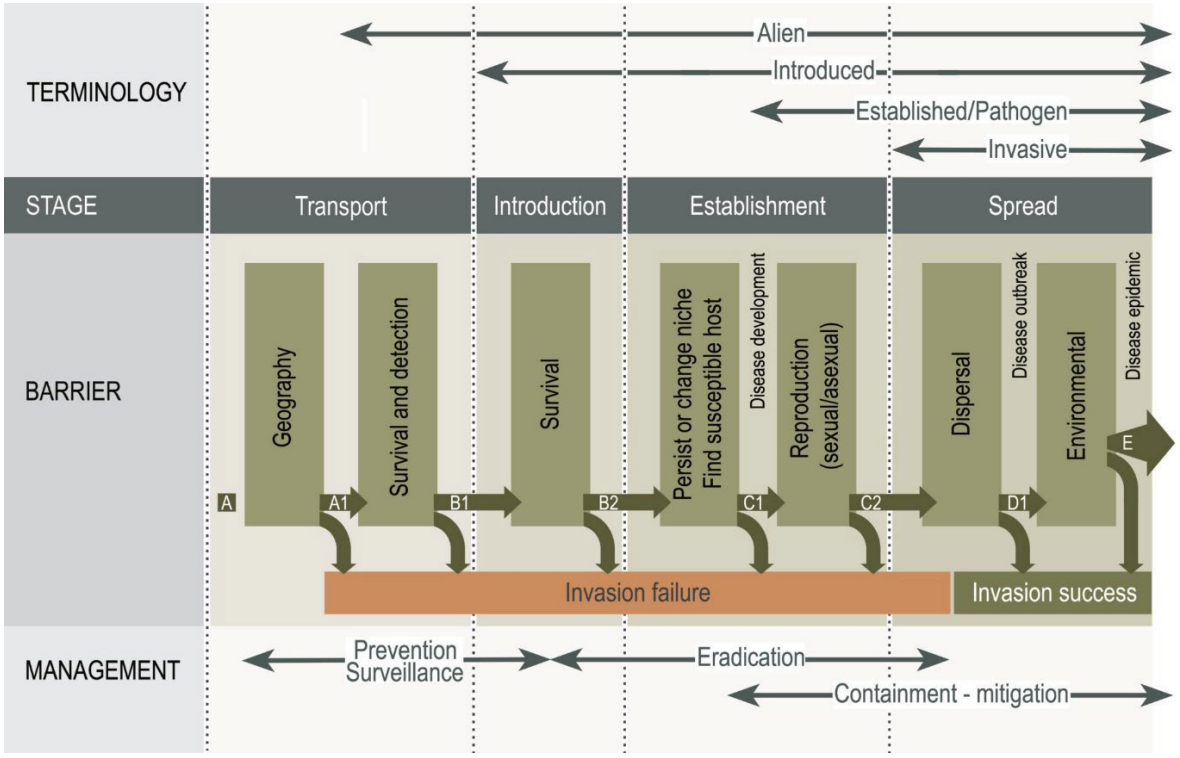



*Figure 1: A proposed framework of the invasion process for forest pathogens.*

The paper published in the journal *Current Forestry Reports*, documents a collaboration between the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria, the South African National Biodiversity Institute, the Centre for Invasion Biology, and other international collaborators, including prominent forest pathologists and invasion scientists. The study, led by Dr Trudy Paap, sought to advance the study of invasive forest pathogens by proposing a modified version of the Unified Framework, to better accommodate invasive forest pathogens (Figure 2). The authors interrogated the key challenges encountered when studying microorganisms as invasive species. They note that the lack of knowledge of microbial biodiversity and ecology, speciation and

geographic origin has hampered researchers seeking to understand invasive forest pathogens under existing frameworks.

Dr Paap says, "*In proposing the revised framework and highlighting the challenges and areas of research needed, we hope to align the work of forest pathologists more closely with that of invasion scientists*." *She adds "With a clearer understanding of how microorganisms move around and the stages they pass through to become invasive, we hope that forest pathologists will better understand how and why invasions occur, and importantly, where, when and how invasions can be stopped or mitigated*."


*Figure 2: Examples of impacts caused by invasive forest pathogens—A) an American chestnut stand gutted by the chestnut blight pathogen, Cryphonectria parasitica (Library of Congress, Prints & Photographs Division, Reproduction number HAER VA,70-LURA.V,4—97); B) Ash dieback in Europe, caused by Hymenoscyphus fraxineus; C) Austropuccinia psidii causing myrtle rust on Myrtus communis in South Africa; a serious threat to European myrtle; D) Phytophthora cinnamomi devastating Proteaceae-dominated ecosystems in southwest Western Australia.*

Read the paper:
Paap T, Wingfield MJ, Burgess TI, Wilson JRU, Richardson DM, Santini A. 2022. Invasion frameworks: a forest pathogen perspective. *Current Forestry Reports*. https://doi.org/10.1007/s40725-021-00157-4

*Unmitigated economic impact of polyphagous shot hole borer estimated at R275 billion*

Another collaboration between the C·I·B, Dr Paap and colleagues including at SU's Department of Conservation Ecology and Entomology and the University of Pretoria's Forestry and Agricultural Biotechnology Institute (FABI) estimates the potential economic impact of the polyphagous shot hole borer in South Africa amounts to a whopping R275 billion over the next ten years, and municipalities will have to bear the brunt of this cost if nothing is done to stem the tide.

Instead of basing their findings on existing data, the team used a modelling approach based on forecasted impacts – thus seeking to simulate possible future impacts of this invader if nothing is done to prevent it from spreading further. The shot hole borer was first detected in South Africa in 2012 and has since spread to eight of South Africa's nine provinces, making it the largest current outbreak of this invasive pest globally. Whereas most of South Africa most notorious invasive species are problematic in rural areas, this aggressive invader will have the largest impact on trees in urban areas.

The findings were published in the article "An assessment of the potential economic impacts of the invasive polyphagous shot hole borer (*Coleoptera Curculionidae*) in South Africa" in the *Journal of Economic Entomology*. Prof**.** Francois Roets, an ecologist in SU's Department of Conservation Ecology and Entomology and one of the co-authors, says a tree-rich town like Stellenbosch stands to lose 20 000 of the big old oaks and plane trees lining its streets. In Somerset West, where the shot hole borer was first detected four years ago, more than 10 000 trees have already been infected and some of the oak trees are now dying.

Prof. Roets says urban trees are more susceptible to succumbing to the beetle's effects as these trees are usually already under stress in an urban environment compared to those in a natural forest rich with biodiversity. People in urban areas also tend to plant more non-native tree species – many of which are cloned and lack the genetic diversity necessary to fight off novel pests.

Prof**.** Martin de Wit, an economist at SU's School for Public Leadership and main author on the article, says that if nothing is done to prevent the further spread of this invader, municipalities country-wide will have to remove and safely dispose of an estimated 65 million urban trees between 2020 and 2030. This excludes trees on private land outside urban areas. "*We need a national policy and coordinated strategy for municipalities to stop this beetle in its tracks*," he warns. "*To date, the polyphagous shot hole borer is not yet listed under the Alien and Invasives Species Regulations, making it difficult for municipalities to react effectively*."

Prof**.** Brian van Wilgen, an ecologist**,** C·I·B Core Team Member and co-author of the study, says the options for managing this invasion are limited: "*Given how widespread it already is, eradication is impossible, and management will have to focus on reducing further spread and mitigating its impacts. A first step, and likely the most economical, will be to restrict the free movement of potentially infested planting material, wood, and wood products*."

The little bit of good news is that the polyphagous shot hole borer can only fly short distances – from 500 metres to two kilometres. Its rapid spread in South Africa is therefore mainly due to people moving wood across municipal and provincial borders. "*The bad news is that a single virgin female can establish a new colony by producing all-male offspring and then mating with them. This "perfect invader" also carries its own food in the form of the fungus Fusarium euwallaceae, an alien species that was co-introduced with the beetle*," explains Prof**.** Roets.

Research is underway to find a biological control agent for the fungus (*Fusarium euwallaceae*) and the beetle. However, "it would take at least a decade before the agent [if one can be found] could be released, and even longer before any significant reduction in spread could be expected," the authors write in the article.

To date, there is no thoroughly tested and approved insecticide or fungicide registered in South Africa to treat infestations of the shot hole borer effectively, at least not for urban trees: "*Anyone who tells you they will save your tree with chemicals and fungicides is likely lying and will be breaking the law*," warns Prof. Roets.

A coordinated strategy to deal with the invasion in South Africa will require a revision of legislation and the creation of policies relating to biological invasions. Currently, there is no coordinated management of invasive species in urban ecosystems, a critical oversight, the authors conclude.

Read the paper:
De Wit, M.P., Crookes, D.J., Blignaut, J.N., De Beer, Z.W., Paap, T., Roets, F., Van der Merwe, C., Van Wilgen, B.W. & Richardson, D.M. (2022) An Assessment of the Potential Economic Impacts of the Invasive Polyphagous Shot Hole Borer (Coleoptera: Curculionidae) in South Africa. *Journal of Economic Entomology*. DOI: https://doi.org/10.1093/jee/toac061

*Risk Analysis- EICAT and SEICAT*

As detailed in Section 5.2 below, the C·I·B contributes to the IUCN's Environmental Impact Classification for Alien Taxa (EICAT), via C·I·B Core Team Member Dr Sabrina Kumschick. Dr Kumschick both established the EICAT Authority and is the incumbent EICAT Authority Chair. 2021 C·I·B Honours student Cally Jansen's thesis was accepted for publication in 2022, thereby helping to contribute to the growing archive of risk assessment, and comparative objective quantification of invasives impacts.

Read the paper:

Jansen C, Kumschick S (2022) A global impact assessment of Acacia species introduced to South Africa. *Biological Invasions* 24: 175-187. https://doi.org/10.1007/s10530-021-02642-0

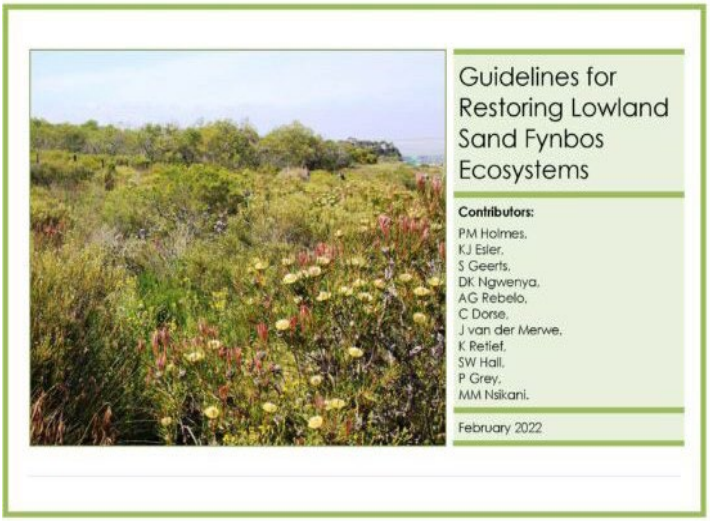
## *1.4 Global environmental change and ecosystem services*

*Restoring Lowland Sand Fynbos- guidelines hot off the press*

As global efforts to up-scale restorative activities emerge under the UN Decade for Ecological Restoration (https://www.decadeonrestoration.org/), a team of South African collaborators has focused ongoing efforts on restoring Lowland Sand Fynbos ecosystems, which are amongst the most threatened habitats in South Africa.

To this end, their collective knowledge and experience has now been collated into 'Guidelines for restoring lowland fynbos systems'. This e-book can be found online at https://scholar.sun.ac.za/handle/10019.1/124162 and on SANBI's Biodiversity advisor at http://biodiversityadvisor.sanbi.org/planning-and-assessment/ecological-restoration/ .

The document leads readers through a description of this critically threatened habitat, providing information on planning and execution of restorative actions, including a norms calculator for alien tree clearing, legal and policy imperatives, in-field protocols, and monitoring. There is a section on troubleshooting challenges, and useful information on seed processing, plans of operation and cost-calculating.




The guidelines aim to assist managers and landowners of degraded Sand Fynbos vegetation to restore biodiversity and contribute to the conservation of these threatened ecosystems. The hope is that these practical guidelines will pave the way for Cape Lowland Fynbos to flourish and to help inspire similar efforts elsewhere.

C·I·B Core Team Member and co-author Prof. Karen Esler gratefully acknowledged funding from the Hans Hoheisen Charitable Trust, to support the development of these guidelines. C·I·B Research associates Prof. P. Holmes, Prof. S. Geerts and Dr M. Nsikani, and students Dr S. Hall and Ms D. Ngwenya were also contributors to these guidelines.

Source the e-book:
Holmes, P.M., Esler, K.J., Geerts, S., Ngwenya, D.K., Rebelo, A.G., Dorse, C., van der Merwe, J., Retief, K., Hall, S.W., Grey, P., Nsikani, MM. 2022. Guidelines for Restoring Lowland Sand Fynbos Ecosystems. Self-published. ISBN: 978-0-620-98765-3

## *1.5 The human dimensions of biological invasions*

*Consensus and controversy in the discipline of invasion science*

A study, C·I·B alumnus and Research Associate Dr Ross Shackleton asks whether controversies divide the field of invasion science? His study found that consensus among invasion science experts is generally high, however, some topics still generate debate.

A global study that assessed researchers' and practitioners' options (698 people) on debated topics in the field of invasion science was conducted by Dr Ross Shackleton (University of Lausanne) in collaboration with former C·I·B PhD student Giovanni Vimercati, Anna Probert and Sven Bacher (all from the University of Fribourg), Christian Kull (University of Lausanne) and former C·I·B post-doctoral associate Ana Novoa (Czech Academy of Sciences), to see where disagreements exist in the invasion science filed and what underlying factors might cause this.

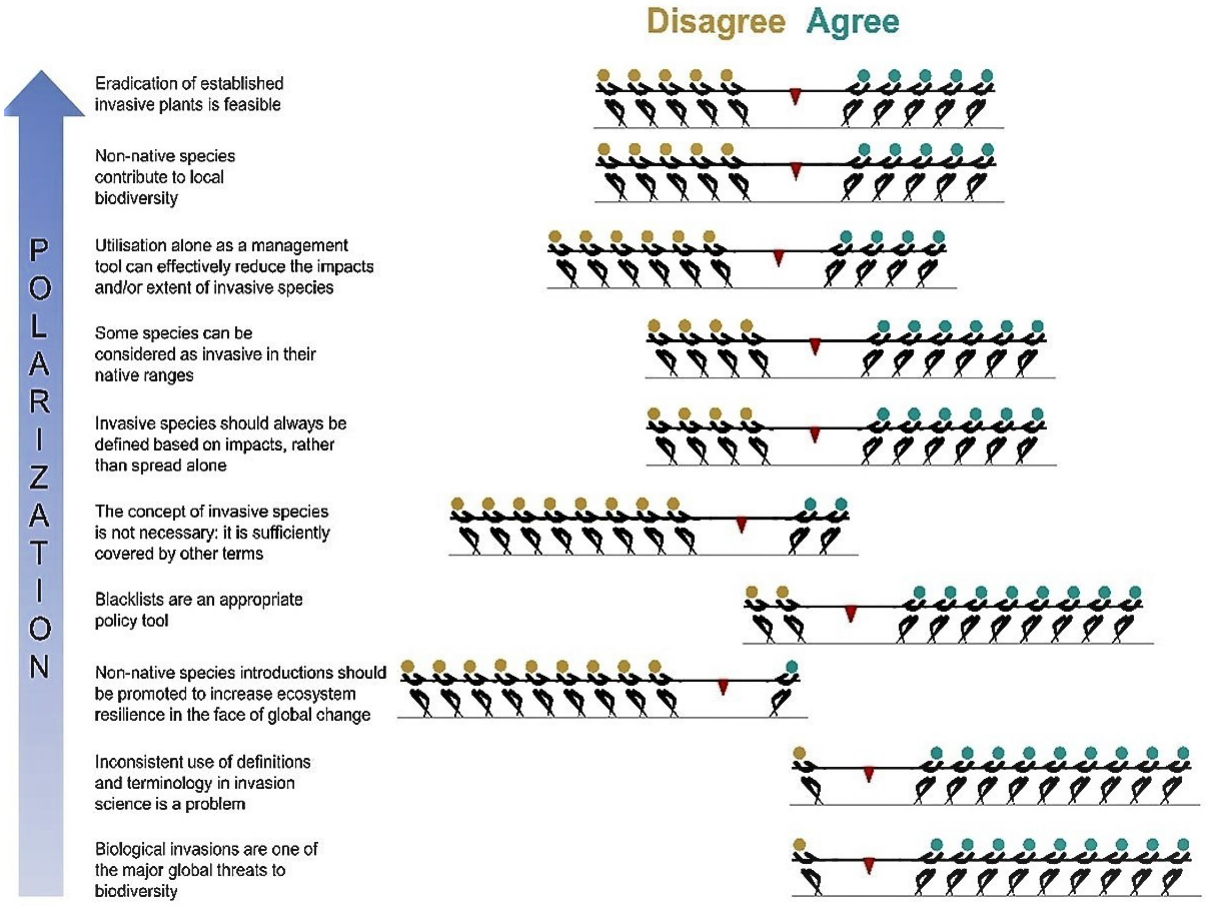
Contexts, approaches, values, and perceptions in invasion science are highly dynamic and this can lead to divergent views as debate in the field. Debates can become counterproductive for science and management if left unchecked. Understanding different perspectives and discourses, and finding solutions to contentious issues and polarized debates, can be crucial for moving research disciplines forward and ensuring effective management.

In the study, Dr Shackleton and co-authors found that most debated topics generally have good consensus now. However, there is still polarization in people's views on some topics. Relating to general values, there was high polarization regarding claims of invasive species denialism, whether invasive species contribute to biodiversity, and how biodiversity reporting should be conducted.

With regards to management, there were polarized views on banning the commercial use of beneficial invasive species, the extent to which stakeholders' perceptions should influence management, whether invasive species use alone is an appropriate control strategy, and whether eradication of invasive plants is possible. For impacts, there was high polarization concerning whether invasive species cause or are a side effect of degradation and whether invasive species benefits are understated. For terminology, there were polarized views related to defining invasive species based only on spread, whether species can be labelled as invasive in their native ranges, and whether the language used is too xenophobic.

Views were particularly divergent and polarised between people working on different invasive taxa (plants and mammals) and in different disciplines (between biologists and social scientists), between academics and practitioners, and between people working in different world regions (especially between Africa and the Global North). Unlike in other studies, age and gender had a limited influence on people's responses. These findings help to better contextualise debates and help with understanding why they arise and persist.

Dr Shackleton discusses that "*Better collaboration between disciplines and different stakeholders globally could help build a broader shared understanding and consensus, and can reduce current and potential debates and conflicts*."




*A few examples of debates with high and low polarization in views. (Image from Shackleton et al., 2022)*

Read the paper:

Shackleton, R.T., Giovanni, V., Probert, A.F., Bacher, S., Kull, C.A. and Novoa, A. (2022) Consensus and controversy in the discipline of invasion science. *Conservation Biology*. doi: 10.1111/cobi.13931

*Understanding the past, present, and future to guide restoration*

A new study by Stellenbosch University researchers shows that a lack of funding, poor communication among stakeholders and inadequate knowledge are the major barriers to successful restoration of riparian zones in the Global South. The results of the study were published in the journal *Ambio*.

Nicola du Plessis (former Stellenbosch University student), Dr Alanna Rebelo (Post-doc researcher) and Prof. Karen Esler (C·I·B Core Team Member) from the Department of Conservation Ecology and Entomology, and Prof. Dave Richardson (C·I·B Core Team Member) conducted an interdisciplinary,

*Long-leafed acacia (Acacia longifolia) is one of the many species of invasive alien trees that have invaded riparian zones in the Western Cape. Successful eradication of such species should be guided by context-specific planning strategies to ensure that specific challenges are mitigated, particularly in areas where resources are limited. (Photo: Nicola du Plessis)*

mixed-method study using remote sensing, historical data, and stakeholder interviews to investigate the extent to which a degraded but ecologically important river in the Western Cape of South Africa, should be restored.

A historical analysis of the Dwars River valley showed that degradation has been caused by a long history of land use and land cover change which has facilitated the invasion of alien trees species including long-leafed acacia (*Acacia longifolia*), white poplar (*Populus alba*), black alder (*Alnus glutinosa*), Port Jackson (*Acacia saligna*), and black wattle (*Acacia mearn*sii). Recent attempts to eradicate these invasions have been unsuccessful, largely owing to barriers and challenges faced by implementers, as well as complexity within the system.

The key barriers preventing full-scale restoration were established to be a lack of sufficient funding, inappropriate funding models, a lack of communication among stakeholders, and a lack of techno-scientific knowledge. Interviews of landowners bordering the Dwars River revealed that although there is general concern for the river's health, there are a variety of diverse and often conflicting perceptions of invasive alien species and how they should be managed.

Due to these barriers and challenges, restoring the entire riparian zone to its historical state is unrealistic. Instead, areas which have not yet crossed biological thresholds (i.e., recent and/or low-density invasions) should be prioritised for rehabilitation to optimize spontaneous succession.
The study also recommends that to achieve this, landowners need to be involved in collective support of future conservation efforts along the river. Education of stakeholders through collaborative social learning is key to this process.

"*Even when the goal is not to restore to a past ecosystem state, a holistic view is needed*," said Nicola du Plessis. "*This is necessary to understand landscape context and to inform appropriate goals along the restoration continuum in the face of new barriers and future opportunities*."

The project was funded by the Water Research Commission.

Read the paper:
Du Plessis, N.S., Rebelo, A.J., Richardson, D.M. *et al.* Guiding restoration of riparian ecosystems degraded by plant invasions: Insights from a complex social-ecological system in the Global South. *Ambio* (2021). https://doi.org/10.1007/s13280-021-01691-y

*The dual purpose of Guava invasion in the Vhembe Biosphere Reserve*

Besides being cultivated for commercial purposes, guava (*Psidium guajava Linn.*) has invaded several rural communities in the Vhembe Biosphere Reserve, South Africa. Guava has benefits that come at a cost – given these conflicting impacts, there is a need to incorporate rural community perceptions in the development of effective management plans to avoid conflicts. So, how do rural communities relate to the guava invasion?

To tackle this question, C·I·B Core Team Member Sheunesu Ruwanza and Gladman Thondhlana (both from Rhodes University) conducted household surveys in four rural communities in the biosphere reserve to understand local people's perceptions, knowledge, and uses of guava.

The survey revealed that local communities are aware of guava invasion and perceive it to be spreading in the area. Local communities mentioned several benefits of guava including fruits for consumption, leaves for medicinal purposes, provides shade and firewood. However, the plant also has some costs such as attraction of problematic animals, displacement of native plants, and reduction of grazing and agricultural space. Most of the respondents thought that the benefits associated with guava outweigh the costs, which perhaps explains why most households are not implementing any control measures.

"We believe that to improve the management of conflict generating invasive alien plants such as guava, two things should be considered, (i) incorporation of rural community's views, and (ii) detailed cost-benefit analysis studies should be prioritised to inform management decisions," says Sheunesu Ruwanza and Gladman Thondhlana, lead authors of the *Ecosystems and People* paper.

*Guava (Psidium guajava L.) an invasive alien tree species that is widely distributed in Vhembe Biosphere Reserve, Limpopo Province of South Africa, where it has both benefits and costs. (Photo credit: Sheunesu Ruwanza)*

Read the full paper:
Ruwanza, S. & Thondhlana, G. 2022. People's perceptions and uses of invasive plant *Psidium guajava* in Vhembe Biosphere Reserve, Limpopo Province of South Africa. *Ecosystems and People* 18(1), 64-75. https://doi.org/10.1080/26395916.2021.2019834

# 2 EDUCATION AND TRAINING

## *2.1 Under-graduate teaching*

With a full return to in-person teaching, the 2022 C·I·B-run course, *BDE 345 Invasion Biology* (Stellenbosch University, 3rd year, 16 credits), was led by C·I·B Core Team Members, Prof. Tammy Robinson-Smythe and Dr Sabrina Kumschick, and by C·I·B Research Associate Dr Nicola van Wilgen. Dealing with the core aspects of invasion biology, this course uses primarily South African examples of biological invasions' problems and to propose solutions. The course was attended by 54 students, of whom 7 passed with distinction. Ten of the BDE 345 students have continued with their Honours degree (in 2023), of whom 27% of the Honours cohort are focusing on invasion biology and/or climate change (affiliated with the C·I·B and School for Climate Studies). The substantial time investment in this course is nonetheless valuable for attracting post-graduate students.

## *2.2 Post-graduate training and early career researchers*

The C·I·B supported 41 post-graduate students and post-docs in 2022, as detailed here:

| Category | No. | % |
|---|---|---|
| All students & post-docs | 41 | 100 |
| **Academic level** | | |
| Hons/4th year | 1 | 2.44% |
| Masters | 13 | 31.71% |
| PhD | 20 | 48.78% |
| Post-doc. associates | 7 | 17.07% |
| **Gender** | | |
| Male | 16 | 39.02% |
| Female | 25 | 60.98% |
| **Student demographics** | | |
| Black | 15 | 36.59% |
| White | 20 | 48.78% |
| Indian | 0 | 0% |
| Coloured | 6 | 14.63% |
| Asian | 0 | 0% |
| **Funding** | | |
| Full/Partial NRF grant | 4 | 9.76% |
| Other/independent | 37 | 90.24% |
| **Disability** | | |
| Disabled | 0 | 0% |
| Not disabled | 41 | 100% |

### *2.3 Career development/alumni*

C·I·B graduates are sought after nationally and internationally for a broad variety of research, advisory, consultancy and applied positions, some of which are reflected here:

| Name | Degree/level | Position |
|---|---|---|
| Abrahams, Brent | PhD, 2021 | Coordinator: Emerging Scholars Initiative<br>Africa Centre for Scholarship, Stellenbosch University International |
| Baxter-Gilbert, James | Postdoc, 2021 | Lecturer, University of Mount Allison, Canada |
| Botha, Lee-Ann | MSc, 2021 | Research Assistant, CapeNature |
| Julius, Rolanda | PhD 2018 | Training coordinator, University of Cape Town |
| Kruger, Natasha | PhD, 2020 | Lecturer, University of Wolverhampton, UK |
| Lithole, Asiashu | MSc, 2016 | Lecturer, UNISA |
| Mazibuko, Dickson | MSc, 2012 | Lecturer, University of Malawi |
| Mbopha, Malukhanye | MSc, 2019 | Assistant Director (Operational Support and Planning), Department of Forestry, Fisheries and the Environment (DFFE) |
| Mokhatla, Mohlamatsane | PhD, 2018 | Senior Lecturer, University of Pretoria |
| Nkuna, Khensani | MSc, 2018 | Intern, SANParks |
| Nsikani, Mlungele | Postdoc, 2020 | Research Scientist, SANBI |
| Saccaggi, Davina | PhD, 2021 | Research entomologist, Citrus Research International (Pty) Ltd |
| Sibiya, Thabang | MSc, 2019 | Scientist: SANParks |
| South, Josie | Postdoc, 2021 | Lecturer, University of Leeds, UK |
| Thompson, Genevieve | PhD, 2012 | Founder & CEO, Gene Vantage |
| Van Zitters, Monique | MSc, 2021 | Intern, World Wildlife Fund (WWF) |
| Wagener, Carla | MSc, 2021 | PhD candidate, Oxford University |

Two of our MSc graduates had exciting research opportunities on South Africa's sub-Antarctic Islands. Mr Sam Tebogo Posie Peta (graduated early in 2022, official completion 2021), led a national ecology and conservation project on Marion Island to monitor all seabirds, including tagging endangered Gentoo penguins (*Pygoscelis papua*) through a breeding season and overwintering. Also a 2021 graduate, Mr Tshililo Kharivha has a SANAP-DFFE post on Gough Island as a Meteorological Technician to the 67$^{th}$ & 68$^{th}$ overwintering expeditions.

Dr Phikolomzi Matikinca was offered a researcher and lecturer position at UKZN's School of Life Sciences upon completion of his dissertation, before he had even graduated with his PhD. Dr Matikinca teaches Biostatistics, Invertebrate Diversity and Ecology, Invertebrate Life on Land, and Biodiversity and Ecology, and also supervises 3rd year (undergraduate) and postgraduate students.

## 3 NETWORKING

### *3.1 Annual Research Meeting*

On 22 November, the C·I·B hosted its Annual Research Meeting (ARM) in Stellenbosch. The hybrid meeting brought together C·I·B postgraduate students, senior academics, as well as research associates and partners of the Centre. This hybrid model further allowed for online participation from international delegates and keynote speakers, and the meeting was opened by Professor Sibusiso Moyo, Stellenbosch University's Vice-Rector for Research, Innovation and Postgraduate Studies. The first speaker of the day was C·I·B founder and former Director Professor Steven Chown, now Professor of Biological Sciences at Monash University, Australia, and Director of Securing Antarctica's Environmental Future, with his keynote address titled *The Case for a C·I·B and its Long-Term Research.*

One of the aims of the Annual Research Meeting is to give post-graduate students the opportunity to

present their research and results. Students presented their work in research pods with diverse themes ranging from invasion ecology and dynamics, impacts of invasions, policy, and management interventions, to post-invasion restoration problems and perspectives. Adding to the day's programme was a thought-provoking keynote address from Professor Camille Parmesan, Director of Research at CNRS Theoretical and Experimental Ecology (SETE), France, focussing on the impacts of climate change on species and their implications for conservation. Acting C·I·B Director, Professor Guy Midgley, emphasized the impacts of climate change on the spread of invasive alien species and the subsequent effects on biodiversity.

The day concluded with a ceremony where the best PhD and MSc presentations were awarded with a travel grant. The award for best PhD was awarded to Siphosenkosi Mbonani (based at University of the Witwatersrand) with his project on prickly pear (*Opuntia engelmannii*) populations in four South African provinces. "*I plan to fund my trip as a Visiting Researcher at the Florida Museum of Natural History, University of Florida, USA. I am aiming to visit and conduct some cytogenetic and population-level research on Cactaceae on the subject of genomic variations among Opuntia species in South Africa (and possibly in their home range, the Americas). The Florida Museum of Natural History is doing relevant and extensive work around this topic, and it would be great to learn new cytogenetic and genomic skills and techniques which will subsequently be developed and used in South Africa to manage cacti invasions*," says Siphosenkosi Mbonani, winner of the best PhD presentation.

Armand Engelbrecht (based at University of Pretoria) was named winner of the best MSc for his project analysing stable isotope ratios of historical and recent samples of invasive and indigenous rodents, and its implications for urbanization in Gauteng Province.

*Winner of the best MSc presentation, Armand Engelbrecht, with his supervisor, Prof. Christian Chimimba.*


*Winner of the best PhD presentation, Siphosenkosi Mbonani with his supervisor Prof. Marcus Byrne.*


*The C·I·B team, as well as online participants, at this year's C·I·B Annual Research Meeting (Photo credit: Anton Jordaan)*

### *3.2 Agreements with partner institutions*

The C·I·B has Memoranda of Understanding with several organisations who work in the biodiversity conservation fields. These have multiple benefits for the C·I·B, adding to our perspectives on the environmental, economic and social impacts of invasive species, and helping us in engaging with the diverse communities who are affected:

| Partner organisation | Partner liaison(s) | Partnership since |
|---|---|---|
| Western Cape Education Department | Jean Goliath | 2006 |
| DEFF: Natural Resources Management | Andrew Wannenburgh | 2008 |
| CapeNature | Andrew Turner | 2006 |
| City of Cape Town (CoCT) | Julia Wood | 2012 |
| Centre for Statistics in Ecology, the Environment and Conservation, University of Cape Town | Res Altwegg | 2016 |
| The Nature Conservancy, South Africa | Louise Stafford | 2018 |
| Institute of Botany, Academy of Sciences of the Czech Republic | Petr Pyšek | 2013 |
| Laboratorio de Invasiones Biológicas, Universidad de Concepción, Chile | Aníbal Pauchard | 2013 |
| ***Other memberships essential to our mission:*** | | |
| CAPE Invasive Alien Animals Working Group | Julia Wood, CoCT/ Andrew Turner, CapeNature | 2008 |
| Soil Ecosystem Research Group | Charlene Janion-Scheepers, UCT | 2011 |
| The Honolulu Challenge | Kevin Smith | 2016 |
| Western Cape Environmental Education Forum | Khuthala Swanepoel | 2014 |

# 4 INFORMATION BROKERAGE

## *4.1 Iimbovane Outreach Project*

The Iimbovane Outreach Project had several highlights during 2022 and remains a valuable science education initiative of the Centre. The project's main objective is to teach learners and educators about biodiversity and invasion science while helping them to develop much-needed practical science skills. The project achieves this by (1) presenting classroom lessons at schools, (2) hosting holiday programmes and (3) educator training workshops.

In 2022, Iimbovane trained 921 Grade 10 learners from 15 schools through 46 classroom lessons and field studies in their respective schoolgrounds. Besides increasing the learners' content knowledge about biodiversity and invasive species during the classroom lessons, Iimbovane also helped the learners develop important practical science skills such as measuring, collecting biological samples, following a scientific protocol, analysing data, formulating conclusions, and using scientific keys and microscopy to identify species.

The Iimbovane team made the most of the school holidays and hosted four multi-day holiday programmes. These workshops were held in the Grootvadersbosch Nature Reserve, in Bainskloof, and at the Kijk in die Pot campsite. These workshops were attended by 61 learners who represented


*A photo collage of Iimbovane Project workshop activities (Photos: Dorette du Plessis)*

the following schools: South Peninsula High School (Cape Town), Luhlaza Secondary School (Khayelitsha), Cape Academy for Mathematics, Science and Technology (Tokai), Swellendam Secondary School (Swellendam), Gerrit du Plessis Secondary School (Riversdal), Emil Weder Secondary School (Genadendal) and Swartberg Secondary School (Caledon).

During these programmes the learners conducted mini-research projects in different ecosystems, for example, fynbos, forest, riparian, and freshwater. Through the fieldwork component, the learners experienced the different methods that ecologists use to collect biodiversity and environmental data.

The learners also get to identify plants and invertebrates which gave them hands-on experience with the use of field guidebooks and microscopes. The practical part of looking at the plants and then identifying them complemented their theoretical understanding of how living organisms are classified, which forms part of their Grade 10 Life Science curriculum. The interactive nature of the research projects allows the learners to learn hands-on skills while collaborating and solving problems as a group. By working in groups, the learners developed their abilities to learn from, to understand and to respect the opinions of learners from other schools and cultural backgrounds. Learners who attended holiday programmes also received valuable training in the use of computer programmes such as Excel and PowerPoint. Many of these learners had never worked on computers before but will now be able to prepare class assignments and presentations using the computer skills they gained during their participation in Iimbovane.

Feedback from learners attending these holiday programmes emphasizes the value of such holiday programmes in helping them to develop skills which they otherwise would not have been able to do.

"*Today I improved my microscope skills. I learned how to make a PowerPoint, learning about insects isn't as easy as you think it is. There's way more to an ant than just a small insect. I never knew it would be that hard just to identify a specific ant - well, I guess these small things are the ones with the most difficulty*."

"*I learned today that there are 5 different ways of capturing different types of insects, the most commonly insects captured are the 'ants'. The 5 different ways are baiting, vacuum, sweep nets, beating and pitfalls. I also learned a plant's name called 'noem-noem' and I saw for the first time a forest tree fern. I learned how to identify plant and invertebrate species*."

Educator training also formed an important aspect of 2022's activities. In April, Iimbovane provided training to the SU's Post Graduate Certificate in Education (PGCE) students. The aim being to equip these future educators with the necessary skills to present a practical field lesson for learners. This training consisted of two days and was attended by 44 PGCE students. Iimbovane also invited PGCE students to assist with Iimbovane's holiday programmes, thereby giving them the opportunity to learn how to plan and implement a practical investigation on biodiversity. In total, six PGCE students assisted with the holiday programmes and a further 121 educators were trained through educator training workshops presented by the Iimbovane.

Over the past years, Iimbovane has established a productive network consisting of various NGOs,

groups and communities that work towards environmental and science education goals. This has led to the co-hosting of several learner workshops with CapeNature, Nature Connect and Cape Leopard Trust in 2022. In addition, the project team were also approached by private schools and home-schooler groups for day programmes on local biodiversity and invasive alien species. Through these collaborative workshops and day programmes, Iimbovane trained a further 142 learners.

Read more at: https://blogs.sun.ac.za/iimbovane/category/news/

## *4.2 Communication with the public*

*Media highlights*

In 2022, the C·I·B's research was reported on in both local and international media, with the following highlights deserving special mention.

A paper co-authored by C·I·B Core Team Member Prof. Brian van Wilgen in August 2022, described the potential economic impacts of the polyphagous shot hole borer, estimated at R275 billion over the next ten years. The paper, published in *Journal of Economic Entomology*, drew much attention from national and international news platforms and led to articles on Sky News, Bloomberg, Business Tech, AgriOrbit, Argus, Saturday Star, Cape Times, Sunday Times and News24. The research received further exposure through radio interviews with the authors on SAfm Sunrise, Cape Talk, Moneyweb and Radio Islam. Popular magazines, such as Landbouweekblad and Engineering News, also featured the research.

Research conducted by C·I·B Core Team Member Dr Llewellyn Foxcroft, based at SANParks, and co-authors received several mentions in the media for their research on the establishment of one of the world's most invasive bird species, the Indian mynah, in the Kruger National Park. The paper, published in *Biological Invasions,* featured in The Times (UK), Mail & Guardian, Daily Maverick, Eyewitness News, Getaway and Farmers Weekly. Dr Foxcroft was also interviewed by John Maytham on his radio show on Cape Talk, with further distribution of the interview on Kfm, ValleyFM and Energy FM.

In 2022, three members of the C·I·B were awarded each with an Eco-Logic Award for their contributions to conservation. The recipients, C·I·B Acting Director Prof. Guy Midgley (Award for Climate Change), C·I·B Core Team Member Prof. van Wilgen (Eco-Warrior Award) and the late C·I·B Research associate Prof. David Le Maitre (Award for Water Conservation) and the award ceremony received media mention with articles in the Cape Argus, iAfrica, Business Media Magazine, Constantiaberg Bulletin and Green Times, as well as mentioned on the radio channel, Smile 90.4 FM.

*Prof. Guy Midgley receives the Climate Change Award from Mr Zolile Nqayi of the DFFE.*

In October 2022, a paper published by C·I·B Core Team Members Brian van Wilgen and John Wilson, attracted interest from both local and international media. The review paper, published in *Biological Conservation*, found that clearing efforts by the Working for Water programme have only reached about 14% of the estimated invaded area in South Africa, and that alien plant invasions continued to grow when assessed at a national scale. The paper has led to numerous articles on news platforms including News24, Business Tech, George Herald, Knysna-Plett Herald, and Maroela Media. The outcomes of the paper were further highlighted in sector specific publications such as Farmers Weekly, Nature Africa, Getaway, Afrinuus and AgriOrbit. Prof. Brian van Wilgen was also interviewed on Cape Talk, Radio 786, RSG and Landbou Radio.

See Appendix 2 for a full list of media interactions.

### *4.3 Web-based services and social media*

**Zenodo** https://zenodo.org/communities/cib

By June 2021 all existing datasets had C·I·B been migrated to the online and open access portal Zenodo following the C·I·B's January 2021 decision to migrate all existing C·I·B datasets from the institutional repository hosted by SU (the former IRSS).

There are 214 records currently stored; includes datasets, theses, reports and publications.

**Web page** https://blogs.sun.ac.za/cib

**20591** unique visitors
**30161** unique page views
**632 downloads**

Most visitors were from Africa, North America, and Europe.

**Facebook** https://www.facebook.com/centreforinvasionbiology

**2184** followers | **2026** like this page
**21** posts | **31** viewers per post (average)

Top 5 posts:

| *Date* | *C·I·B nugget* | *People reached* |
|---|---|---|
| 19 October 2022 | Post-doc advertisement | 1 637 |
| 9 December 2022 | Condolences to loss of C·I·B Associate, Prof. David Le Maitre | 1 064 |
| 11 April 2022 | Invasive crayfish can cause high fisheries damage | 917 |
| 31 March 2022 | Invite to citizen scientists to track the Tree of Heaven | 809 |
| 6 May 2022 | Generation of machine-learning training samples using traditional image classification algorithms | 553 |

**Twitter** @invasionscience

**43** total Tweets | **1673** followers
Per day average: **247** impressions | **135** link clicks | **75** retweets | **209** likes | **8** replies

**Top Tweet:**
Invasive crayfish can cause high fisheries damage? [2927 impressions]

## 5 SERVICE PROVISION

### *5.1 The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem (IPBES)*

Established in 2012, IPBES is an independent intergovernmental body that now has 137 members. An 'IPCC for biodiversity', IPBES works to strengthen scientific knowledge forming the basis for better policy, for the conservation and sustainable use of biodiversity, long-term human well-being and

sustainable development. IPBES has undertaken assessment of a wide range of specific themes of global importance relating to biodiversity and ecosystem Services. Past assessments on pollination and food production, land degradation and restoration, sustainable use of wild species and on methodologies were followed in 2019 by a report on "Global assessment of biodiversity and ecosystem services" citing global reductions in biodiversity, which prompted assessment of biological invasions and potential control measures involving many C·I·B Core Team Members and graduates, and is scheduled for release late in 2023.

## *5.2 EICAT & SEICAT*

The Environmental Impact Classification for Alien Taxa (EICAT) is the IUCN's standard for assessing impacts of alien species. The C·I·B is involved in several activities around EICAT: a) C·I·B Core team member Sabrina Kumschick established the EICAT Authority and is the EICAT Authority Chair. The EICAT Authority reviews EICAT assessments before they are published on the Global Invasive Species Database (GISD) website to ensure quality standards are met; b) the C·I·B provides the secretariat for the EICAT Authority, which is filled by Tanushri Govender; c) several C·I·B Core team members and students have contributed EICAT assessments to the GISD; this will be the most comprehensive global database on impacts of alien species, and is compiled in a transparent and standardised manner.

Regular EICAT Authority online meetings were held (chaired by Sabrina Kumschick) in 2022 to discuss operational issues around EICAT, as well as the development of guidelines, templates, training materials, and assessments. 189 EICAT assessments have been reviewed and accepted for publication to date, of which 110 have been published on the GISD website.

The C·I·B has, through various projects, developed EICAT assessments, either for student theses or for collaborative research projects. These assessments are all transferred to the IUCN's standard template and submitted to the EICAT Authority for review and publication on the GISD website. Most notably, a book chapter on alien acacias was written, which includes EICAT and SEICAT assessments for all alien *Acacia* spp. globally.

The Socio-economic Impact Classification of Alien Taxa (SEICAT) is a framework to assess socioeconomic impact of alien taxa on human well-being in a transparent and evidence-based manner. The main aim of SEICAT is to provide a framework in which all impacts on human well-being can be captured. This framework was co-developed by several C·I·B Core team members and international colleagues. The framework will eventually be used to develop a database of impacts of alien species on human well-being.

The SEICAT framework was published in the scientific literature (with several C·I·B authors), and additional guidance documents are being prepared and developed. Several applications of the framework have also been published, most notably a study by C·I·B Core Team Member Sabrina Kumschick and C·I·B Hons student Cally Jansen on alien acacias in South Africa.

## *5.3 The Alien Species Risk Analysis Review Panel (ASRARP)*

The Alien Species Risk Analysis Review Panel is a panel set up to review risk analysis produced following the Risk Analysis for Alien Taxa framework to underpin the regulation of alien species under the National Environmental Management: Biodiversity Act, Alien and Invasive Species Regulations. Several C·I·B Core Team Members serve on the panel, including John Wilson and Sabrina Kumschick. Furthermore, many C·I·B Core Team Members, students and affiliates have contributed to the workings of the panel by producing risk analyses, reviewing risk analyses, and serving as experts.

## *5.4 Panels and committees*

### *5.4.1 International*

EICAT Authority: Member (Measey)
EICAT Authority: Chair (Kumschick)
GEO BON Species Populations Working Group: Member (Wilson)
ICREA Peer Evaluation (Esler)
LIFE CROAA: Commission Européenne dans le cadre du programme européen LIFE: Member (Measey)
Namdeb Terrestrial Scientific Committee Member (Esler)
International Initiative for Theoretical Ecology, IITE London: Trustee (Hui)
IPBES (Inter-governmental science-policy platform on biodiversity and ecosystem services) – invasive alien species assessment: Lead Author (Foxcroft)
IPBES – Invasive Alien Species Assessment - Review Editor(s) (Hui; Richardson)
IPBES – thematic assessment of invasive alien species and their control: Review panel member (Robinson-Smythe)
IPBES IAS Assessment: Review Editor ~ Technical Advisor (Wilson)
IUCN Academy, The: Training Conservation Leaders (Esler)
IUCN Species Survival Commission (SSC), The – Amphibian Specialist Group: Member (Measey)
IUCN SSC – Conifers: Member (Richardson)
IUCN SSC – Invasive Species Specialist Group: Member(s) (Foxcroft; Kumschick; Richardson; Wilson)
IUCN SSC– Ladybird Species Group: Member (Clusella-Trullas)
IUCN-SSC Otter Specialist Group: Member and Southern African Coordinator (Somers).
IUCN-SSC Re-introduction Specialist Group: Member (Somers).
IUCN SSC– Spiders, Scorpions and: Advisory board member (Foord)
IUCN-SSC Small Carnivore Specialist Group: Member (Somers)
IUCN-SSC Wild Pig Specialist Group: Member (Somers).
Science Foundation Ireland; Virtual Review of the SFI Research Centre for Bioeconomy: Member (Esler)

In addition, C·I·B Core team members participated in 4 international grant reviews for external bodies, in 2 appointment reviews; in twenty-three NRF rating and project proposal reviews, and service on 3 NRF panels and committees.

#### *5.4.2 National*

Alien Species Risk Analysis Review Panel (ASRARP): member (Kumschick)
Centre for Sustainability Transitions (CST) Governing Board (Esler)
Endangered Wildlife Trust Animal Ethics Committee: Member (Somers)
Fynbos Forum Committee: Member (Esler)
IUCN Wild Dog Advisory Group of South Africa: Member (Somers)
JW Oppenheimer Research Grant: Expert Panel Member (Chimimba)
Managing invasions in Marine Protected Areas Task Team: Co-chair (Robinson-Smythe)
Marine Protected Areas Forum, Advisory committee member (Robinson-Smythe)
Marine Alien and Invasive Species Working Group, Chair (Robinson-Smythe)
Reference and Advisory Committee- National Status Report on Biological Invasions in South Africa: Member (Foxcroft)
Royal Society of South Africa: Fellow of the (Wilson)
South African Alien Species Risk Analysis Review Panel: Secretariat (Wilson)
Southern African Mountain Conference- Scientific Committee: Member (Foxcroft)
Southern African Wildlife College Training Advisory Committee (Esler)
WRC Reference Group: The use of long-term, large-scale data combined with historic ecological data to support reserve implementation: Member (Esler)

### *5.5 Editorial and refereeing activities*

#### *5.5.1 Editor-in-Chief / Editor / Thematic/Regional Editor*

*African Biodiversity and Conservation: Bothalia* (Wilson)
*Aquatic Invasions* (Robinson)
*BioInvasion Records* (Robinson)
*Conservation Biology,* Regional Editor Africa (Esler)
*Journal of Experimental Biology* (Terblanche)
*NeoBiota, Subject Editor* (Wilson)
*Vegetos* (Mokotjomela)

#### *5.5.2 Associate Editor*

*African Biodiversity and Conservation (Bothalia)* (Ruwanza)
*African Journal of Wildlife Research* (Somers)
*Aquatic Invasions* (Zengeya)
*BioInvasions Records* (Measey, Zengeya)
*Biological Invasions* (Hui, Kumschick, Richardson)
*Bulletin of Mathematical Biology* (Hui)
*Ecological Complexity* (Hui)
*Ecological Solutions and Evidence* (Zengeya)
*Fire Ecology* (van Wilgen)
*Forest Ecosystems* (Richardson)
*Frontiers in Mammal Science* (Chimimba)
*Global Ecology and Biogeography* (Hui)
*Herpetological Conservation & Biology* (Measey)

*Koedoe* (Somers)
*Mammalian Biology* (Somers)
*NeoBiota* (Foxcroft, Kumschick, Richardson)
*PeerJ* (Measey)
*Salamandra* (Measey)

### *5.5.3 Editorial Boards*

*AoB PLANTS* (Richardson)
*BMC Ecology and Evolution*, Editorial Board member (Hui)
*Current Research in Insect Science*, Editorial Board member (Terblanche)
*Frontiers in Ecology and Evolution*, Editorial Board member (Hui)
*Journal of Dynamics and Games*, Editorial Board member (Hui)
*Journal of Experimental Biology*, Editorial Board member (Clusella-Trullas)
*Journal of Insect Physiology*, Editorial Board member (Terblanche)
*Koedoe*, Editorial Board member (Foord; Foxcroft)
*Nature Conservation Research* (Editorial Board member- resigned in 2022) (Somers)
*Vegetos*, Editorial Board member (Mokotjomela)
*Zookeys*, Editorial Board member (Foord)

In addition to the above editorial roles, the C·I·B Core team contributed to the robustness and diligence of invasions' science by also performing multiple reviews for 7 national journals*, and more than 87 international journals†.

**African Entomology; African Journal of Aquatic Science; African Journal of Marine Science; South African Journal of Botany (multiple reviews); South African Journal of Plant and Soil; South African Journal of Science*; and *Transactions of the Royal Society of South Africa.*

†*African Journal of Ecology* (multiple)*; African Journal of Range & Forage Science; African Ecology; Agricultural and Forest Meteorology; Ambio; American Naturalist; Amphibia-Reptilia; Austral Ecology* (multiple)*; Biofouling; Biological Conservation; Biological Invasions* (multiple)*; Biological Reviews; Biological Control; Biocontrol Science and Technology; Conservation Biology* (multiple)*; Conservation Letters; Current Research in Insect Science; Diversity* (multiple)*;Ecosystems; Ecosystem Services; Ecological Indicators* (multiple)*; Ecological Solutions and Evidence; Ecology and Evolution; Ecosphere; FEMS Microbiology Ecology; Frontiers; Frontiers in Ecology and Evolution; Frontiers in Environmental Health; Frontiers: Marine Conservation and sustainability; Functional Ecology; Global Change Biology; Global Ecology and Biogeography* (multiple)*; Global Ecology and Conservation* (multiple)*; Herpetology Notes; Invasive Plant Science and Management; Journal of Animal Ecology; Journal of Applied Ecology* (multiple)*; Journal of Arid Environments; Journal of Asia-Pacific Entomology Diversity and Distributions; Journal of Ecology; Journal of Environmental Management* (multiple)*; Journal of Experimental Biology; Journal of Insect Physiology; Journal of Natural History; Journal of Thermal Biology* (multiple)*; Journal of Zoology, London; Learned Publishing; Marine Pollution Bulletin; Management of Biological Invasions; Nature; Neobiota* (multiple)*; New Phytologist* (multiple)*; PeerJ* (multiple)*; Phyton International Journal of Experimental Botany; Plant and Soil; Plants; Qeios; Restoration Ecology; Science of the Total Environment* (multiple)*; Scientific African; Scientific Reports; Vegetos; Weed Research; World Development Sustainability;* and *Zoosystematics and Evolution.*

# 6 GOVERNANCE AND ORGANIZATIONAL STRUCTURE

## *6.1 Steering Committee*

| Name | Affiliation | Role |
|---|---|---|
| Prof. John Donaldson | Independent consultant | Chair |
| Prof. Eugene Cloete* | Vice-rector, Research development, Innovation and Postgraduate studies, Stellenbosch University | Ex-officio member |
| Prof. Louise Warnich | Dean, Faculty of Science, Stellenbosch University | Ex-officio member |
| Prof. Dave Richardson† | Director, Centre for Invasion Biology, Stellenbosch University | Ex-officio member |
| Prof. John Measey** | Deputy-Director, Research Strategy, Centre for Invasion Biology, Stellenbosch University | Ex-officio member |
| Dr Makobetsa Khati | Executive Director (RCCE), National Research Foundation | NRF representative |
| Mr Nathan Sassman | Director, Research Chairs and Centres of Excellence (RCCE), National Research Foundation | NRF representative |
| Ms Rose Msiza | Director, Research Support, Department of Science & Innovation | DSI representative |
| Mr Leluma Matooane | Director, Earth Systems Science, Department of Science & Innovation | DSI representative |
| Prof. Michael Somers | Eugène Marais Chair of Wildlife Management, Mammal Research Institute, University of Pretoria | C·I·B core team representative |
| Dr Angus Paterson | Managing Director, South African Institute for Aquatic Biodiversity | Industry Representative |
| Mr Michael Braack | Director, Biosecurity, Natural Resource Management Programme, Department of Environment, Forestry and Fisheries | Industry Representative |
| Dr Theressa Frantz | Chief Director: Biodiversity Research, Assessment & Monitoring, South African National Biodiversity Institute | Industry Representative |
| Prof. Sheona Shackleton | Deputy Director, African Climate and Development Initiative (ACDI), University of Cape Town | Industry Representative |
| Prof. Piero Genovesi | Director, ISPRA Institute for Environmental Protection and Research, Italy | International Science Advisor |
| Prof. Laura Meyerson | Professor, Department of Natural Resources Science, The University of Rhode Island, USA | International Science Advisor |
| Prof. Guy Midgley†† | Acting Director, Centre for Invasion Biology and School for Climate Studies, Stellenbosch University | Ex-officio |

*Prof. Cloete stepped down as SU Vice-Rector in mid-2022 and was succeeded 1 September 2022 by Prof. Sibusiso Moyo.

†Prof. Richardson discontinued his Directorship of the C·I·B effective 31 March 2022; he remains a C·I·B Core team member.

**Prof. Measey discontinued his staff role and thus his SteerCom role 31 March 2022; he also remains a Core team member; and

††Prof. Midgley took up the role of Acting Director of the C·I·B effective 1 April 2022.

## *6.2 Personnel involved in the CoE*

### *6.2.1 C·I·B Core team members*

| Name | Institution | Race | Gender | Citizenship | % time @ C·I·B | NRF rating |
|---|---|---|---|---|---|---|
| Byrne, Marcus, Prof. | Wits | W | M | RSA | 30% | B1 |
| Chimimba, Chris, Prof. | UP | B | M | RSA | 25% | C1 |
| Clusella-Trullas, Susana, Prof. | SU | W | F | RSA | 20% | C |
| Downs, Colleen, Prof. | UKZN | W | F | RSA | 10% | C |
| Esler, Karen, Prof. | SU | W | F | RSA | 10% | B3 |
| Foord, Stefan, Prof. | UniVen | W | M | RSA | 5% | C2 |
| Foxcroft, Llewellyn, Prof. | SANParks | W | M | RSA | 20% | C1 |
| Hui, Cang, Prof. | SU | A | M | RSA | 5% | B2 |
| Kumschick, Sabrina, Dr | SU | W | F | Switzerland | 100% | C1 |
| Measey, John, Prof. | SU | W | M | UK | 25% | C |
| Mokotjomela, Thabiso, Dr | SANBI | B | M | RSA | 20% | pending |
| Rahlao, Sebataolo, Dr | EKZNW | B | M | RSA | 5% | Not rated |
| Richardson, David, Prof. | SU | W | M | RSA | 100% | A1 |
| Robertson, Mark, Prof. | UP | W | M | RSA | 10% | C1 |
| Robinson-Smythe, Tammy, Prof. | SU | W | F | RSA | 80% | C1 |
| Ruwanza, Sheunesu, Dr | RU | B | M | RSA | 20% | Y2 |
| Somers, Michael, Prof. | UP | W | M | RSA | 10% | C1 |
| Terblanche, John, Prof. | SU | W | M | RSA | 10% | B1 |
| Van Wilgen, Brian, Prof. | SU | W | M | RSA | 25% | B1 |
| Wilson, John, Prof. | SU | W | M | RSA | 80% | B |
| Zengeya, Tsungai, Dr | SANBI | B | M | RSA | 30% | C3 |

### *6.2.2 C·I·B Research Associates*

| Name | Affiliation |
|---|---|
| Alexander, Mhairi, Dr | University of West Scotland, UK (animal behaviour ecologist) |
| Blackburn, Tim, Prof. | Chair of Invasion Biology at Centre for Biodiversity and Environment Research in Department of Genetics, Evolution & Environment, University College London, UK (bird ecologist) |
| Blanchard, Ryan, Dr | Biodiversity and Ecosystems Services research group, Natural Resources and the Environment, CSIR (plant ecology) |
| Davies, Sarah, Dr | Ecologist, Centre for Scientific and Industrial Research (CSIR) |

| | |
|---|---|
| Essl, Franz, Prof. | University of Vienna, Austria (ecologist in biological invasions, macroecology & Global Change) |
| Gaertner, Mirijam, Prof. | Environmental Sciences programme head, Nürtingen-Geislingen University of Applied Science, Germany (restoration ecologist) |
| Geerts, Sjirk, Prof. | Cape Peninsula University of Technology (plant ecologist) |
| Giliomee, Jan, Prof. | Emeritus Professor, Stellenbosch University (entomology) |
| Holmes, Patricia, Prof. | Extraordinary Professor, Department of Conservation and Entomology, Stellenbosch University (restoration ecologist) |
| Jackson, Michelle, Dr | Department of Zoology, University of Oxford, UK (freshwater ecologist) |
| Janion-Scheepers, Charlene, Dr* | Department of Biological Sciences, University of Cape Town (entomologist) |
| Jordaan, Martine, Dr | Scientific Services, CapeNature (aquatic ecology) |
| Kueffer, Christoph, Prof. | Department of Environmental Systems Science, ETH Zurich, Switzerland (plant ecologist) |
| Le Maitre, David, Prof. † | Extraordinary Professor, Department of Conservation and Entomology, Stellenbosch University (plant ecologist and hydrologist) |
| Le Roux, Jaco, Prof. | Department of Biological Sciences, Macquarie University, Australia (plant ecologist) |
| Nsikani, Mlungele, Dr | South African National Biodiversity Institute (restoration ecologist) |
| Pepler, Dave | Free-lance media expert (media) |
| Pyšek, Petr, Prof.** | Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic (plant ecologist) |
| Ricciardi, Anthony, Prof. | Redpath Museum & School of Environment, McGill University, Canada (freshwater ecologist) |
| Shackleton, Ross, Dr | Swiss Federal Institute for Forest, Snow and Landscape Research, Switzerland (plant ecologist) |
| South, Josie, Dr | University of Leeds, UK (freshwater ecologist) |
| Van Wilgen, Nicola, Dr | SANParks Scientific Services, Cape Cluster (animal ecologist) |
| Woodford, Darragh, Dr | School of Animal, Plant and Environmental, University of the Witwatersrand (freshwater ecologist) |

*Dr Janion-Scheepers to take up a Core team membership in 2023, in support of the C·I·B reopening its long-term transect in the Cederberg.

†*The C·I·B was saddened by the death of Prof. Le Maitre in early December 2022 following several years' battle with cancer- please see the memorial frontispiece.

**Prof. Petr Pyšek resigned his Research Associateship effective 31 December 2022.

### *6.2.3 C·I·B Staff*

| Name | Position | Race | Gender |
|---|---|---|---|
| Du Plessis, Dorette, Ms | Iimbovane Outreach Programme manager | W | F |
| Kritzinger-Klopper, Suzaan, Ms | Chief technical officer | W | F |
| Kumschick, Sabrina, Dr | Researcher | W | F |
| Marais, Elrike, Dr | Research & project manager | W | F |
| Measey, John, Prof.* | Deputy Director: Research Strategy | W | M |
| Midgley, Guy F., Prof. | Acting Director | W | M |
| Momberg, Christy, Mrs | Management administrator | W | F |
| Msomi, Londiwe, Ms | Education outreach officer | B | F |
| Nortje, Erika, Ms | Ecophysiology lab manager | W | F |
| Richardson, Dave, Prof.† | Science advisor | W | M |

*Prof. Measey finished his staff role 31 March 2022 (but retains his Core Team Membership, above).

†Prof. Richardson will return from sabbatical July 2023 however, will not resume C·I·B directorship.

### *6.2.4 C·I·B Management Committee*

| Name | Affiliation |
|---|---|
| Measey, John, Prof. | SU and Yunnan University |
| Midgley, Guy F., Prof. (Chair) | Acting Director |
| Somers, Michael, Prof. | University of Pretoria |
| Zengeya, Tsungai, Dr | South African National Biodiversity Institute |

C·I·B management administrator Christy Momberg is the scribe.

### *6.2.5 C·I·B Scientific Advisory Committee*

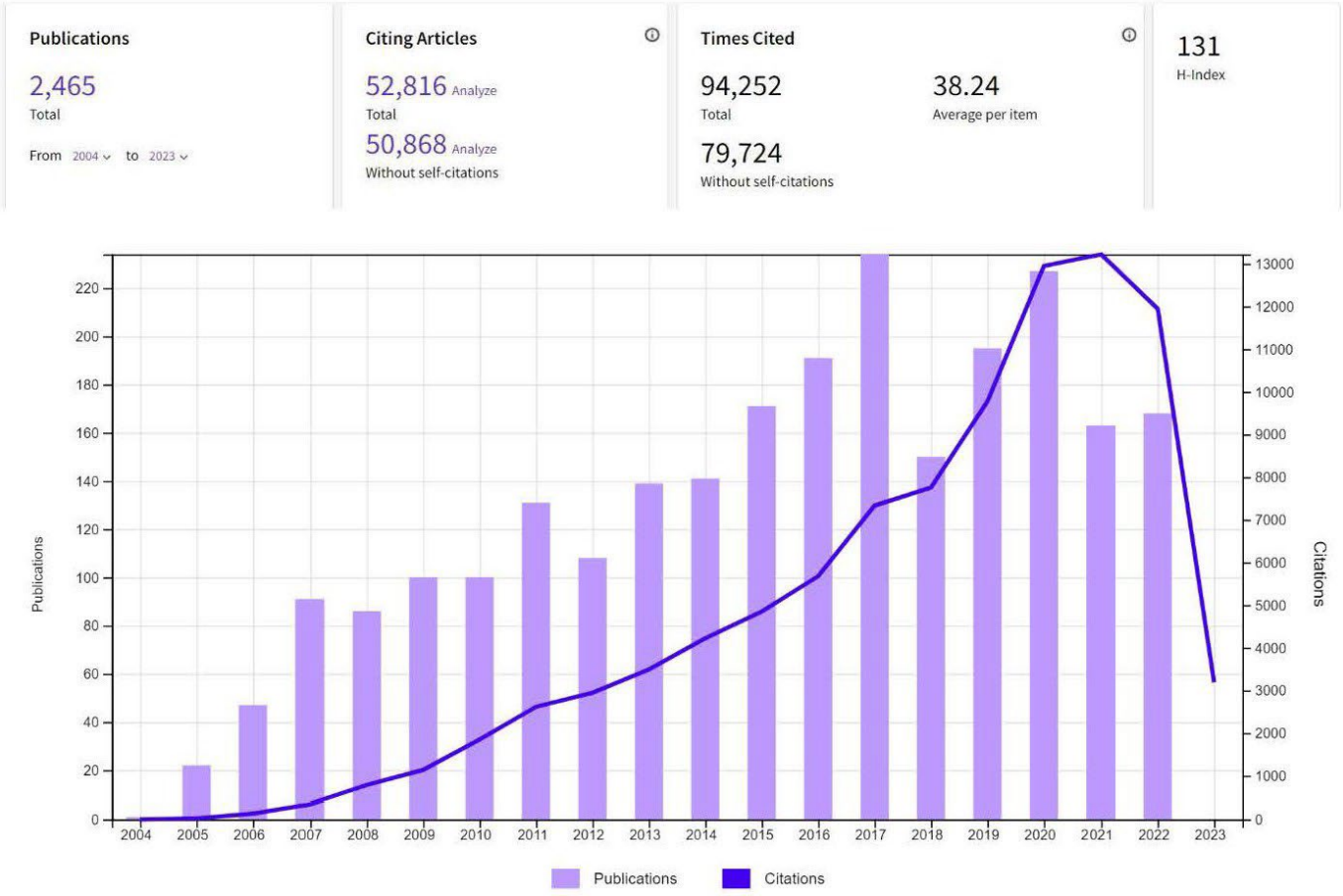
| Name | Affiliation |
|---|---|
| Genovesi, Piero, Dr | Chair, IUCN Invasive Species Specialist Group |
| Measey, John, Prof. | SU and Yunnan University |
| Meyerson, Laura, Prof. | University of Rhode Island, USA |
| Midgley, Guy F., Prof. | Acting Director |
| Slingsby, Jasper, Dr | University of Cape Town |
| Zengeya, Tsungai, Dr | South African National Biodiversity Institute |

See Appendix 3 for details of C·I·B post-docs and students.

# 7 RETURN ON RESEARCH INVESTMENT

The C·I·B published 105 papers in peer-reviewed journals in 2022, continuing to publish leading invasions outputs as a major return on South African investment.

Citation impact




The C·I·B's citation report, above, covers the period 2004 to 2022 inclusive. (http://apps.webofknowledge.com)

# 8 PROGRESS AGAINST SERVICE LEVEL AGREEMENT TARGETS

The C·I·B operated under Service Level Agreement (SLA) No. 7 (2020-2022), with the following targets, deliverables and results during 2022:

## *8.1 Governance*

| | | | |
|---|---|---|---|
| Two Steering Committee (virtual or real) meetings should take place per annum | 2022 target was Feb & Oct/Nov | 23 March; & 25 November 2022 | 100% |
| Student nominations submitted to the NRF's student database | 2022 target = by deadline determined by the NRF | Deadline met | 100% |
| Annual Progress Reporting on all activities undertaken during the year for review by the Steering Committee | Target = End Feb of following year | NRF Online APR submitted directly to NRF on 15FEB; SC, SU-endorsed version emailed to NRF 1MAR | 100% |

## *8.2 Research outputs*

| | | | |
|---|---|---|---|
| Peer-reviewed research papers published | 2022 target = 50 | 105 | exceeded |
| Peer-reviewed papers with IF > 15 published | Target = 2/pa | 3* | exceeded |
| Peer-reviewed papers with IF > 4 published | Target = 10 | 33 | exceeded |

*In 2022, the C·I·B had publications in *Trends in Ecology & Evolution* (~20.589 IF), *Nature Ecology & Evolution* (~19.1 IF), and *Science* (~63.714 IF).

## *8.3 Education and training*

| | | | |
|---|---|---|---|
| Student registrations supported by the centre with either full, partial or independent funding | *2022 target was 10* | 41 | exceeded |
| Honours students graduated | *Target = 2* | 1 | 50% |
| Masters students graduated | *Target = 2* | 4 | exceeded |
| PhD students graduated | *Target = 0* | 2 | exceeded |
| Post-docs completed | *Target = 0* | 2 | exceeded |
| Female students supported | *Target = 55%* | 61% | exceeded |
| Black students supported | *Target = 90%* | 51.2% | short |
| SA student citizens & permanent residents, of which Black 90%, White 10%, Disabled 1% | *Target = 95%* | 85.4% | short |
| Post-docs or early-career researchers as proportion of supported researchers | *Target = 10% pa* | 17% | exceeded |

## *8.4 Networking*

| | | |
|---|---|---|
| The CoE will publish vignettes of information on its website and provide these to the NRF | *2022 target = annual delivery to NRF* | 42 vignettes were published on the C·I·B website, and further publicized via Facebook, Twitter. Vignettes remitted to NRF on 27 January 2023. |
| Co-host SARChI Chair in Biodiversity Value and Change in the Vhembe Biosphere Reserve | *Ostensibly phased out in 2020* | The UniVen SARChi Chair and lab have become the C·I·B's new Northern Hub |

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|---|---|---|---|
| Memoranda of Understanding with key regional, national and international partners | *Maintain under appropriate branding* | In process of determining future network, possible funding flow to identify needed MoAs | |
| Joint supervision of students outside the core team and at other universities | *2022 target was 1* | 17 | exceeded |
| Maintain a network of actively engaged Research Associates | *5-10 Research Associate-led papers per year* | 16 | exceeded |
| National conference attendance | *2022 target = 5* | 37 | exceeded |
| International conference attendance | *2022 target = 5* | 41 | exceeded |
| National conference/workshop organization | *2022 target = 0* | 0 | met |
| International conference/workshop organized | *2022 target = 0* | 1 | exceeded |

## *8.5 Information brokerage and outreach*

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| Maintain an Information Retrieval and Submission System (IRSS) that curates the outputs of the Centre | *Phased out* | The C·I·B segment of the Zenodo platform went live, and all existing datasets were migrated in 2021. |
| Social media engagements with partners and interested parties (DSI-NRF branding) | *Use of 'DSI-NRF' to be terminated 14SEPT2023* | Active profiles on two social media platforms (Facebook, Twitter) as well as the Centre's website. Vignettes of 2022 submitted to the NRF on 27 January 2023. |
| Iimbovane outreach activities continue in 20 schools | *No 2022 target* | Iimbovane held training activities in 15 schools. |
| Classroom and field-based lessons presented at schools | *No 2022 target* | Delivered 46 field-based and classroom lessons at Iimbovane partner schools. |
| Number of learners participating in the Iimbovane Outreach Project | *No 2022 target* | 1124 learners participated in Iimbovane during school-based activities and lessons. Iimbovane also trained 165 educators. |

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| News interest in both print and online media | *2022 target = 5* | 72 | exceeded |
| Popular articles and talks in both print and online media | *2025 target = 2* | 26 | exceeded |

### *8.6 Service provision*

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|---|---|---|---|
| Rating and scientific reviews for the NRF | *2022 target was 5* | 26 | Exceeded |
| Peer evaluations for national and international grant-making bodies | *target = 2* | 8 | exceeded |
| Participation in international science organizations | *target = 5* | 26 | exceeded |
| Journal editorships (editor, associate editor or editorial board membership) | *target = 5* | 36 | exceeded |
| Reviewing activities for national and international journals. | *target = 5* | ~87 | exceeded |
| Inputs to policy relevant processes and documents | *target = 1* | NSR & ASRARP | exceeded |

# 9 CONCLUSION

Following 2021 challenges, in 2022 the C·I·B focused on advancing several new opportunities towards ensuring retention and growth of its valuable national and international capacity, especially through its alignment with Stellenbosch University's School for Climate Studies (SCS). The progress made by the Research Chair, Managing Invasive Species in Protected Areas, and the successful pursuit of additional funding opportunities (with welcome support in this final period from the NRF for replacement of hardware and an allocation for outreach), and the performance of students and affiliated researchers in their publication success and in presentations at the Annual Research Meeting (ARM), all demonstrate the C·I·B's sustainability and momentum in advancing invasive species research, including research into rehabilitation, conservation and ecosystem services.

While some uncertainty around the start date and thus end of the CoE transition period posed challenges in planning the scope of remaining projects and funding allocations, especially due to delayed receipt of the End-of-Funding Modalities Guide, the C·I·B exceeded the majority of its 2022 targets with significant contributions to high-impact journals and key publications specializing in biological invasions. The C·I·B's focus on research, education and training, networking, information brokerage and outreach, and service provision has yielded positive outcomes. The support provided to students, the successful hybrid Annual Research Meeting, and the impactful outreach efforts of the Iimbovane team showcase the C·I·B's commitment to knowledge dissemination and capacity building. Regarding gender representation, the C·I·B demonstrates good gender balance across its core team, associates, staff, post-docs, and students.

Securing funding beyond 2023 remains a top priority for the C·I·B, and the ongoing collaboration with Stellenbosch University's School for Climate Studies presents a promising opportunity. However, the need for "glue funding" to support vital functions and staff roles is an ongoing challenge that is being addressed in formal discussion with Stellenbosch University structures. Overall, the C·I·B's collaboration with the Stellenbosch University's SCS, and the strongly overlapping expertise between theory and practice in invasive species and climate change research position the C·I·B well for future success in addressing local to global ecological and climate challenges. The transition into a key pillar of the School for Climate Studies will thus allow for continued growth, leveraging networks, synergizing research efforts, and building upon shared ecological and earth science priorities.

While uncertainties and challenges persist, the C·I·B and its staff remain dedicated to its mission of advancing invasion biology research, fostering collaboration, and increasingly to contributing to biodiversity conservation and climate change adaptation and mitigation efforts in potentially a research entity that is globally unique.

# APPENDICES

## *APPENDIX 1- PUBLICATION OUTPUTS*

### *Peer-reviewed publications*

Adams, L, Martin, G, Downs, C, Clark, V, Thabethe, V, Raji, I and Steenhuisen, S (2022). Seed dispersal by frugivores and germination of the invasive alien shrub *Pyracantha angustifolia* (Franch.) C.K. Schneid. in Free State Province, South Africa. *Biological Invasions* 24, 2809–2819. https://doi.org/10.1007/s10530-022-02807-5

Adlam, AL, Chimimba, CT, Hugo Retief, DC, & Woodborne, S (2022). Modelling water temperature in the lower Olifants River and the implications for climate change. *South African Journal of Science* 118 (7-8), 1-6; http://dx.doi.org/10.17159/sajs.2022/12953

Afonso, L, Esler, K, Gaertner, M, Geerts, S (2022) The invasive alien *Hypericum canariense* in South Africa: Management, cost and eradication feasibility. *South African Journal of Botany* 146, 685-694.

Alexander, ME, Skein, L and Robinson, TB (2022). Rapid learning in a native predator shifts diet preferences towards invasive prey. *Biology Letters* 18: 20210655. DOI: 10.1098/rsbl.2021.0655

Baxter-Gilbert, JH, Riley, JL, Wagener, C, Baider, C, Florens, FBV, Kowalski, P, Campbell, M, & Measey, J (2022) Island hopping through urban filters: anthropogenic habitats and colonized landscapes alter morphological and performance traits of an invasive amphibian. *Animals* 12(19), 2549; https://doi.org/10.3390/ani12192549

Becker, F, Altwegg, R, Slingsby, J, Measey, J, Tolley, KA (2022) Finding rare species and estimating the probability that all occupied sites have been found. *Ecological Applications* 32(2), e2502. https://doi.org/10.1002/eap.2502

Bierman, A, Roets, F, Terblanche, JS Population structure of the invasive ambrosia beetle, *Euwallacea fornicatus*, indicates multiple introductions into South Africa. 2022. *Biological Invasions* 24, 2301-2312.

Bitani, N and Downs, CT (2022). The native avian species visiting fruiting invasive *Lantana camara* in KwaZulu-Natal, South Africa: Potential dispersal concerns. *South African Journal of Botany* 148, 573-579. https://doi.org/10.1016/j.sajb.2022.05.032

Bitani, N, Shivambu, TC, Shivambu, N and Downs, CT (2022). An impact assessment of alien invasive plants in South Africa generally dispersed by native avian species. *Neobiota* 74, 189-207. https://doi.org/10.3897/neobiota.74.83342

Botella, C, Bonnet, P, Hui, C, Joly, A & Richardson, D.M. (2022). Mechanistic-statistical modeling reveals the pivotal role of human-mediated long-distance dispersal in plant invasion dynamics. *Biology* 11(9), 1293; https://doi.org/10.3390/biology11091293.

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Catford JA, Wilson JRU, Pyšek P, Hulme PE, Duncan RP (2022) Addressing context dependence in ecology. *Trends in Ecology & Evolution*, 37, 2 (Feb), 158–170. https://doi.org/10.1016/j.tree.2021.09.007

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Cowie, BW, Byrne, MJ & Witkowski, ETF (2022) Small-scale insights into the above- and below-ground invasion dynamics of *Parthenium hysterophorus* in a South African savanna: The potential role of stocking rate. *South African Journal of Botany* 144, 229-237. 10.1016/j.sajb.2021.08.035

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## *APPENDIX 2- MEDIA OUTPUTS*

### *Newspapers*

Bega, S. 2022. Indian mynas take wing in Kruger. Mail & Guardian. 4 November 2022.

Bega, S. 2022. Invasive parakeets ruffle feathers. Mail & Guardian. 25 November 2022.

Chambers, D. 2022. SA records first karaka poisoning case. Daily Dispatch. 15 December 2022.

Fleming, H. 2022. Rose-ringed parakeet alert issued for the Kruger. The Lowvelder. 20 October 2022.

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Smillie, S. 2022. Joburg's urban forest at peril. Saturday Star. 25 June 2022.

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### *Popular articles and talks*

#### *Articles*

Coleman, A. 2022. More money needed to curb invasive species in SA. Farmer's Weekly. 24 November 2022.

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#### *Talks*

Esler, K.J. Connectedness and reciprocity with nature: a personal tale in pursuit of well-being. Open for Climate Justice Public Lecture, Stellenbosch University, October 2022.

Foxcroft, C. Alien species invasions and management efforts in Kruger National Park and surrounds. Department of Forestry, Fisheries and the Environment (DFFE) Mbombela Invasive Species Forum, Mbombela.

Foxcroft, L.C. Alien species invasions and management efforts in Kruger National Park. National Science Foundation (NSF)/University of Mississippi and FABI/University of Pretoria Invasion Biology Course, Berg-en-Dal.

Foxcroft, L.C. Biological Invasions in Kruger National Park: status, threats and options. South African National Parks Honorary Rangers Indaba, Skukuza.

Robinson, T.B. Marine alien species and the threat they pose in marine protected areas. Webinar hosted by the World Wildlife Fund, 2022.

*Online media*

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## *APPENDIX 3- SUPPORTED POST-DOCS AND STUDENTS*

### *C·I·B post-doctoral fellows*

| Name | Citizenship | Institution | Race | Gender | Status | Funding |
|---|---|---|---|---|---|---|
| Bierman, Anandi | RSA | SU | W | F | Continuing | Independent |
| Botella, Christophe* | France | SU | W | M | Continuing | Independent |
| Fernandez-Winzer, L. | Argentina | SU | W | F | Continuing | Independent |
| Mcculloch-Jones, E. | RSA | SU | W | F | Continuing | Independent |
| Melotto, Andrea | Italy | SU | W | M | Completed | Independent |
| Potgieter, Luke | RSA | SU | W | M | Continuing | Independent |
| Van Velden, Julia | RSA | SU | W | F | Continuing | Independent |

*Dr Botella completed his full-time post-doc early in 2023 yet will remain a collaborator on an ongoing research project with his C·I·B team.

### *C·I·B students supported by the Centre in 2022*

| Name | Citizenship | Institution | Race | Gender | Status | Funding |
|---|---|---|---|---|---|---|
| **BSc (Honours)/4th year B. Agric.** | | | | | | |
| De Beer, Isabella | RSA | SU | W | F | Completed | Independent |
| **MSc/Masters** | | | | | | |
| Bell, Jonathan | RSA | SU | W | M | Continuing | Independent |
| Carelse, Gaylen | RSA | SU | C | F | Continuing | Partial |
| Collop, Amy* | RSA | SU | C | F | Completed | Full |
| Du Plessis, Aneesa | RSA | CPUT | C | F | Discontinued | Full |
| Engelbrecht, Armand | RSA | UP | W | M | Continuing | Partial (+HCID direct) |
| Lehman, Tevan* | RSA | SU | | | Completed | Independent |
| Mahlobo, Thandeka* | RSA | UKZN | B | F | Completed | Full |
| Matthys, Chelsey | RSA | CPUT | C | F | Continuing | Independent |
| Pienaar, Madeleine | RSA | SU | W | F | Continuing | Full |
| Sadan, Tashreeqah | RSA | CPUT | C | F | Continuing | Independent |
| Seboko, Tshepiso* | RSA | RU | B | M | Completed | Full |
| Ter Huurne, Michele | RSA | SU | W | F | Continuing | Independent |
| Van Blerk, Dan | RSA | SU | W | M | Completed | Independent |
| Visagie, Marizanne | RSA | SU | W | F | Continuing | Independent |

*While document/thesis requirements may have been met earlier, Ms Collop and Mr Lehman graduated in April 2022 (Mr Lehman obtained his MSc cum laude). Ms Mahlobo graduated in May 2022, and Mr Seboko graduated in October 2022.

| PhD | | | | | | |
|---|---|---|---|---|---|---|
| Araspin, Laurie | France | SU | W | F | Continuing | Partial |
| Bolosha, Uviwe* | RSA | RU | B | F | Continuing | Full (formerly) |
| Bosua, Henrika | RSA | SU | W | F | Continuing | Full |
| Duncan, Patricia | RSA | SU | W | F | Continuing | Partial |
| Maimela, Lerato T.† | RSA | UP | B | F | Completed | Partial |
| Mapaura, Anthony† | Zimbabwe | UFS | B | M | Completed | Partial |
| Matikinca, Phikolomzi | RSA | SU | B | M | Completed | Independent |
| Mbobo, Tumeka S. | RSA | SU | B | F | Completed | Independent |
| Mbonani, Sipho | RSA | Wits | B | M | Continuing | Full |
| Mudau, Phuluso | RSA | Wits | B | M | Continuing | Full |
| Nelufule, Takalani† | RSA | UP | B | M | Completed | Independent |
| Ngwenya, Duduzile | Zimbabwe | SU | B | F | Continuing | Full |
| Ntsonge, Sinazo* | RSA | RU | B | F | Completed | Full (formerly) |
| Nxele, Beka | RSA | SU | B | M | Continuing | Independent |
| Ramahlo, M.* | RSA | UP | B | F | Continuing | Independent* |
| Steyn, Clara | RSA | SU | W | F | Continuing | Independent |
| Szewczuk, A.M. | RSA | Wits | W | F | Continuing | Independent |
| van der Colff, D | RSA | SU | C | F | Continuing | Independent |
| Yapi, Thozamile | RSA | RU | B | M | Completing | Partial |

*Ms Bolosha was formerly fully funded, and sought extension funding in 2022, to complete her research and write up her PhD dissertation, which is due for submission in May 2023.

Ms Ntsonge was also previously fully funded. She submitted her PhD thesis early in 2023.

Ms Ramahlo had previously been fully funded. Her studies have been delayed by Covid19, such that she and her supervisor Prof. M. Somers applied for C·I·B funding to complete her PhD in mid-2023.

Dr Brent Abrahams (reported in 2021) graduated in April 2022.

†Mr Mapaura satisfied all the requirements for his PhD on 17 November 2022 and convocated in April 2023.

Ms Maimela submitted her dissertation in late 2022, and is to graduate in 2023.

Mr Nelufule also met all his PhD requirements late in 2022, and will graduate in 2023.

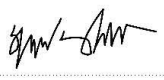
As mentioned above in the Executive Summary, the C·I·B exceeded its target for female students and post-docs (61% actual vs 55% target) but did not achieve its target for black students (51.2% actual vs 90% target). It should be noted that this latter target rose 10% in the C·I·B's final CoE stage, at a time that NRF support reduced 25%/pa and the NRF disallowed new students whose study period would exceed the CoE period- only 9.5% of C·I·B students were NRF-funded.

# *APPENDIX 4- AUDITED FINANCIAL STATEMENTS*

**STELLENBOSCH UNIVERSITY**
**DSI-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY**

**STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 31 DECEMBER 2022**

| | 2022<br>R | 2021<br>R |
|---|---|---|
| **INCOME** | **13 240 198,11** | **14 198 023,04** |
| National Research Foundation grant | 5 464 955,09 | 6 886 539,90 |
| Other income | 3 210 158,69 | 3 789 450,25 |
| Stellenbosch University contribution | 1 033 403,20 | 1 033 403,20 |
| Donation | 2 628 000,00 | 2 016 000,00 |
| Interest received | 903 681,13 | 469 829,69 |
| Profit on sale of asset | - | 2 800,00 |
| **EXPENDITURE** | **9 066 482,97** | **10 700 394,89** |
| Operational expenses | 3 378 978,55 | 4 540 486,14 |
| Audit fees - current year | 63 853,75 | 56 248,80 |
| - under provision previous year | 4 057,62 | - |
| Clothing | 6 037,00 | 1 599,00 |
| Consumables | 127 746,46 | 7 472,54 |
| Consultation | - | - |
| Copying and stationery | 27 175,21 | 29 344,87 |
| Depreciation | 103 565,44 | 189 955,41 |
| Entertainment | 17 609,46 | 14 086,75 |
| Entertainment - workshops | - | - |
| Foreign exchange loss | - | 7 543,91 |
| Furniture and Equipment | 638 069,27 | 5 449,27 |
| Interest paid | 4 442,12 | 235,53 |
| Insurance | - | - |
| Indirect cost recovery | | |
| Stellenbosch University indirect cost levy | 230 961,00 | 186 246,51 |
| Membership and affiliation fees | - | - |
| Non-capitalised books | - | - |
| Prizes | 60 000,00 | 60 000,00 |
| Small capital works: not capitalised | 7 693,77 | 7 895,00 |
| Postage, telephone and fax | 51 835,91 | 40 712,03 |
| Safety clothing | | |
| Rent paid for facilities | - | - |
| Repairs | 168 087,37 | 70 126,12 |
| Software and internet | 5 048,09 | 16 235,00 |
| Sponsorships and donations | - | - |
| Student and post-doc bursaries | 920 000,00 | 2 437 800,00 |
| Sundry expenses | 4 277,48 | 1 065,60 |
| Team member research costs | 651 655,00 | 1 256 748,14 |
| Transport and accommodation | 215 664,56 | 68 054,34 |
| Workshops | 71 199,04 | 83 667,32 |
| | - | - |
| Personnel expenses | 5 687 504,42 | 6 159 908,75 |
| Salaries | 5 687 504,42 | 6 159 908,75 |
| **PROFIT/(LOSS) FOR THE YEAR** | **4 173 715,14** | **3 497 628,15** |



20 April 2023

pp Dave Richardson
Director: DSI- NRF Centre of Excellence in Invasion Biology
Stellenbosch University
Date: