South African
NATIONAL PARKS

2018/19 SANParks Research Report

South African
NATIONAL PARKS

The Editorial team: Corli Wigley-Coetsee, Nicola Bredenkamp,
Nerina Kruger, Izak Smit
Editorial codirect: Stef Freitag-Ronaldson, Danny Govender
Section editors: Marna Herbst, Tercia Strydom, Louise Swemmer, Graham Durrheim
Cover photo: Blister beetle (*Mylabris* sp.) © Sam Droege

Contact SANParks: +27 (0)13 735 4000

Cape Research Centre
Tokai: +27 (0)21 713 7500

Garden Route Research Unit
Knysna: +27 (0)44 302 5600
Rondevlei: +27 (0)44 343 1302
Saasveld: +27 (0)44 871 0058

Savanna & Arid Research Unit
Kimberley: +27 (0)53 832 5488
Phalaborwa: +27 (0)13 735 3534 (SAEON)
Skukuza: +27 (0)13 735 4235

LITHOTECH

Printed by: Lithotech Nelspruit +27 (0)13 752 4116

Layout: Paul Ecroignard at Lithotech DTP +27 (0)11 474 1820

Foreword

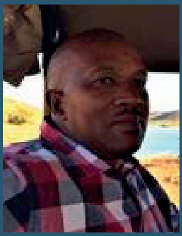
SANParks is responsible for the management of 19 national parks (NPs) in South Africa, covering an area of over 4 million hectares. These parks vary in size and function, from large, fairly intact systems like the Kruger NP and Kalahari Gemsbok NP which also from part of larger trans-frontier conservation areas, to large marine protected areas (MPAs) like Namaqua and Agulhas MPAs and urban, open-access parks like Table Mountain NP. This is an increasing mandate with existing parks expanding and new protected areas being proclaimed like the recently proclaimed Phakisa Marine Protected Areas. Each park plays a unique role in conserving the rich biological diversity, ecosystem processes and cultural heritage of our country. South Africa is the third most biodiverse country in the world and its National Parks and Marine Protected Areas are a very important means of protecting and sharing this biodiversity with both the local and international community. SANParks also have a long reputation where these parks act as attractive real-world socio-ecological "laboratories" for local and international researchers, with the knowledge gained through this research helping to inform SANParks with management of the national parks in a world with ever increasing pressures and expectations from protected areas.

SANParks has increasingly had to consider the varying mosaic of land uses, socio-economic settings, and stakeholder groups surrounding each of its National Parks, or visiting from further afield. These varied groups and land uses, often with different expectations towards the parks, influence how effective we are in achieving longer term sustainability of protected areas, and therefore need to be considered in setting even short and medium term goals. To this end, SANParks follows a stakeholder engagement process to decide on the purpose, vital attributes and key priorities for each park. These are then further cascaded down to operational plans and prioritised to fit within budget realities. Research (basic and applied), monitoring and evaluation are essential aspects to check if park objectives are being met and to facilitate knowledge co-production and learning for continuous improvement in management of protected areas.

SANParks objectives are also nested within the larger international and national strategies such as the Strategic Development Goals, the National Development Plan and national commitments to international treaties and conventions such as the Convention on Biological Diversity. SANParks is committed to contribute to community socio-economic transformation through supporting energy, food, and water security, while carefully managing the trade-offs between conservation and societal needs. It also requires us to find innovative ways to support integrated thinking, joint planning and strategic decision making within and between government departments, and together with industry partners. To do this, however, we need to continually sort through the clutter of perceived crises and sometimes narrowly-conceived agendas to identify key issues that need urgent attention, whilst considering long-term desirable outcomes.

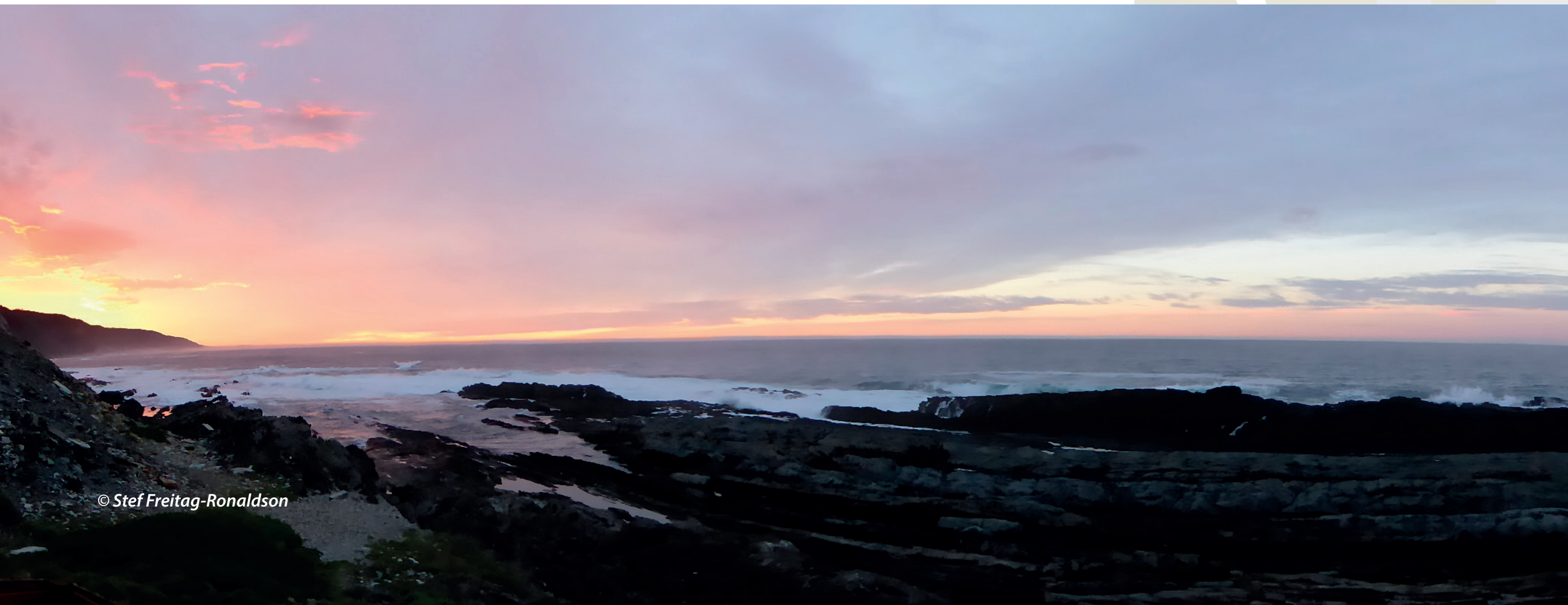
In an age of artificial intelligence, machine learning, genetic engineering, Big Data algorithms and blockchain and an increasing removal of the ordinary citizen from the natural world, natural scientists and conservationists need to consider how to keep their research, emerging narratives and therefore also themselves, relevant in a society that is changing fast and in unpredictable ways. This rapid evolution in Information Technology in the age of the 4th Industrial Revolution presents both challenges and opportunities unknown to previous generations. Conservation agencies like SANParks will need to develop capacity to process the large amounts of information that are currently generated, manage the flow of accurate data and information for management as well as information generated by and consumed by the public. In the short term, this is overwhelming but as institutions and society in general adapt, there will be effective ways of integrating this information in a manner that supports management. Use of remote sensing by satellites and drones alike, environmental DNA and other state-of-the-art tools, together with increased processing capacity for big data allow us to explore novel patterns and dynamics, which will ultimately enhance the quality of decision making over large spatial and temporal scales.

Scientists will, therefore, need to play an active role in packaging scientifically credible messages that the public can access, use to inform their decisions and behaviours and relate to emotionally. Fake news, narrow and emotive rather than rationally and properly contextualised reporting, manufactured crises and unquestioned beliefs in the "facts" spread on social media are increasingly threatening the quest for and relevance of truth and knowledge based on observation and evidence. In this future of "information overload", scientists can assist society with critical thinking, communication, collaboration and being creative in the ways we do our research, learning and knowledge construction. By giving the public an opportunity to participate in the process of knowledge production will give us the best chance of that knowledge being accepted in an era where the boundaries between "fact" and "fiction" is increasingly blurred.



Luthando Dziba
Managing Executive: Conservation Services

Danie Pienaar
General Manager: Scientific Services



© Stef Freitag-Ronaldson

THIS ANNUAL RESEARCH REPORT IS ONE OF THE MECHANISMS IN WHICH SANPARKS PACKAGE AND COMMUNICATE A SELECTION OF RESEARCH PROJECTS CONDUCTED BY SANPARKS SCIENTISTS AND COLLABORATORS. IT IS ABOUT SHARING A VARIETY OF LESSONS LEARNED AND THE KNOWLEDGE CREATED DURING THE PAST YEAR, BUT ALSO ABOUT THE PEOPLE BEHIND THE OUTSTANDING WORK DONE TO UNDERSTAND THE ECOLOGY AND MANAGEMENT OF OUR NATIONAL PARKS. WE ARE VERY PROUD OF THE FORMIDABLE TEAM OF RESEARCHERS AND SCIENCE SUPPORT STAFF WHO GO THE EXTRA MILE TO IMPROVE OUR KNOWLEDGE ABOUT SOUTH AFRICA'S NATURAL AND CULTURAL HERITAGE.

Contents

NEWS AND VIEWS

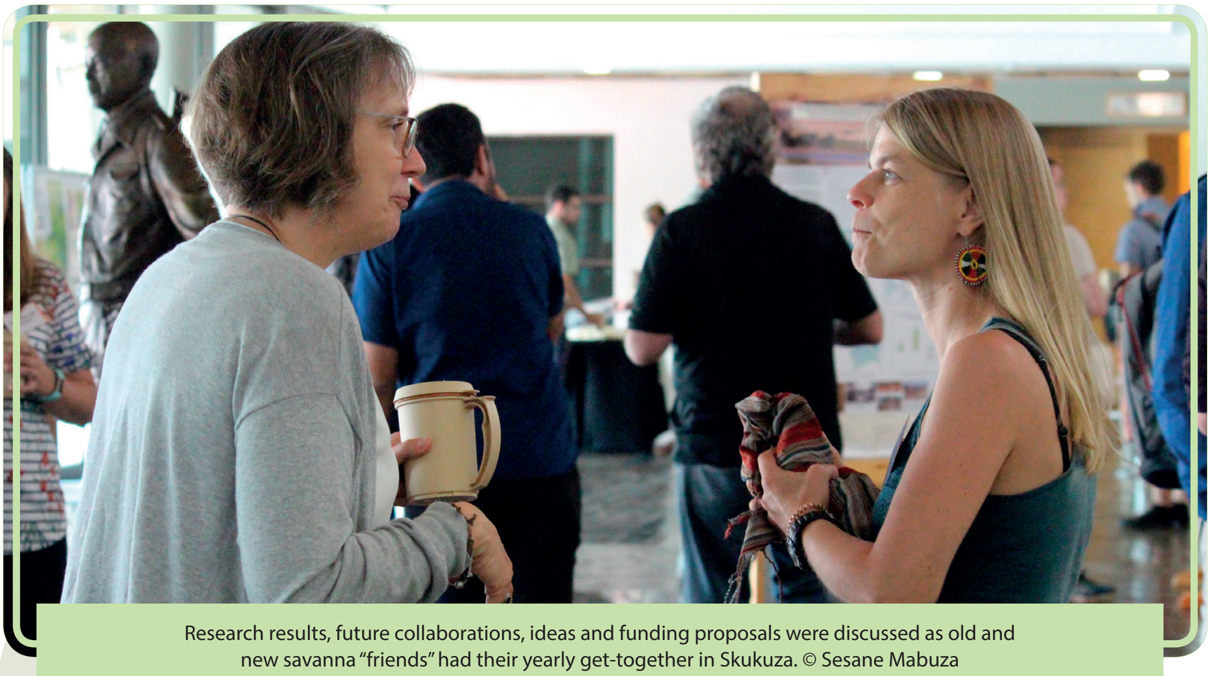
MEETINGS & CONFERENCES HOSTED BY SANPARKS

© Alison Kock


Izak Smit


Judith Botha

17th International Savanna Science Network Meeting


Research results, future collaborations, ideas and funding proposals were discussed as old and new savanna "friends" had their yearly get-together in Skukuza. © Sesane Mabuza

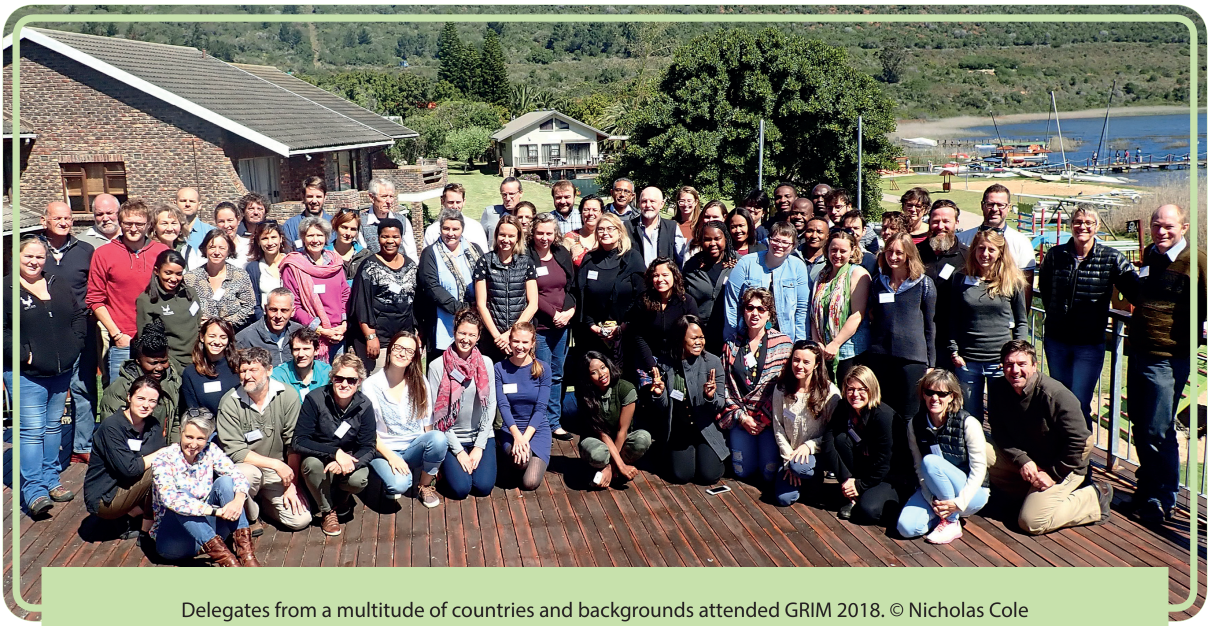
SANParks Scientific Services hosted scientists, researchers and managers from around the world at the 17th Annual International Savanna Science Network Meeting which took place from 4 - 9 March 2019, in Skukuza. The meeting was attended by 201 national and international delegates representing 92 different scientific and conservation organisations. The program included 126 platform and 26 poster presentations. This meeting has grown from one encouraging scientific dialogue around biological research in Kruger National Park (KNP) to one which now encourages a broader social-ecological savanna focus from across different continents.

Many topical issues in ecological and social sciences were covered. This year there was a particular focus on climate change and how the effects play out in protected areas. Linked to that was a session reflecting on lessons learned during the recent drought that KNP and surrounding areas experienced. Some of the other synthesis talks presented included topics on bush encroachment, as another symptom of climate change, governance and management of rivers in the complex Lowveld socio-ecological system, and perspectives on the upcoming global CITES meeting. In order to stimulate discussion and co-learning between the managers and researchers around topics relevant to management of the greater KNP, an additional morning session was added on the last day that allowed managers to interact with some of the scientists who attended the meeting


Listening attentively to more than 120 presentations covering a wide range of topics pertinent to the understanding and management of savannas. © Sesane Mabuza

Second Garden Route Interface meeting and associated Spring School

Dirk Roux



Delegates from a multitude of countries and backgrounds attended GRIM 2018. © Nicholas Cole

During October 2018, SANParks hosted the second Garden Route Interface Meeting (GRIM) at Pine Lake Marina near Sedgefield. GRIM is an annual Garden Route event and provides a forum for interaction between researchers and practitioners interested in better understanding and managing social aspects of conservation. The 2018 meeting, presented with partner organisations Nelson Mandela University and the French CNRS, was attended by 73 delegates including South Africa, France, Finland, Spain, Canada, Kenya and Nigeria. Key discussion themes centered around the use of social media data to understand people-nature interactions, balancing benefits and conflicts, multi-scale governance challenges, and learning with stakeholders. A highlight for delegates was the mid-meeting excursion to the Knysna forest for a picnic lunch and forest walk. GRIM was followed by a five-day Spring School for post-graduate students interested in social-ecological research, lead by the same partner organisations. Fifteen students from a host of countries participated in this learning event.

A highlight of GRIM 2018 was the opportunity for people and nature to interact during the forest excursion. © Dirk Roux

Cloverley Lawrence

Communicating Science: The 2018 Addo Marine Symposium

The Addo Marine Symposium was held at the Addo Elephant National Park Interpretive Centre in October 2018. This one-day workshop provides an important platform that brings together external researchers and SANParks' managers and scientists, and facilitates engagement on key research projects in Algoa Bay, central to the Addo Marine Protected Area (MPA). The symposium hosted 32 delegates; 12 researchers from four institutions, and 20 SANParks management and scientific staff from the Frontier Region. Six research themes – seabirds (penguins and gannets), marine mammals (whales, dolphins and seals), inshore ecosystems, marine predators, reefs and MPAs – were addressed. Presentations were followed by a discussion session where particular issues and concerns were raised by SANParks managers and plans for future research were discussed. Gaps in research were highlighted at the meeting, including the need for projects on alien invasives, harmful algal blooms and socio-economic studies. On that afternoon, delegates welcomed the news that the proposed Addo Elephant National Park MPA had been endorsed by the South African Cabinet, which was then later gazetted.

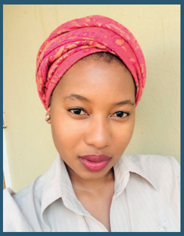
Participants at the 2018 Addo Marine Symposium which took place during October in Addo Elephant National Park allowed for key research feedback and discussion between scientists and managers. © Zukisa Tiza

Scientific Service keeps on Growing and Grooming

The Grow and Groom workshop has become an important part of Scientific Services' annual calendar. The 2018/9 dialogue was hosted in Golden Gate Highlands National Park in February 2019, attended by 57 Scientific Services colleagues (scientists, bio-technicians, support staff and science managers). The Grow and Groom event focused on and allowed for reflection on various topics and themes through a combination of plenary and parallel break away sessions. These included personal reflections and key learnings from the year, grooming future journal editors, reflecting on personal careers, growth and aspirations within the science function, scientific outreach and communication, and learning from the past to shape future park management and research.

The group capitalized on the unique opportunity to take in the rich paleo-history of the park by joining palaeontologist, Viktor Redermacher, from the University of the Witwatersrand, to search for dinosaur fossils. This and other shared outdoor experiences such as abseiling, running, game driving and spontaneous group song helped to facilitate meaningful relationship building and create a sense of common purpose and passion for our work. The group departed Golden Gate reconnected, energised and ready to give their best in their various roles within Scientific Services.

Tercia Strydom



Samantha Mabuza

Roxanne Erusan

Stefanie Freitag-Ronaldson

Fifty-seven Scientific Services colleagues, including scientists, bio-technicians, support staff and science managers met in Golden Gate Highlands National Park to reflect on personal and collective growth within SANParks. © SANParks

Group exercise reflecting on what Scientific Service staff believes to be the best part of their jobs. © Stefanie Freitag-Ronaldson

Who said scientists are dull? Dinner party fun embracing our diversity. © Stefanie Freitag-Ronaldson

Hosting the 2018 International INSAKA Symposium on "sustaining ecosystem service benefits from green and ecological infrastructure"

Louise Swemmer

Insaka is a consortium of universities and non-academic partners, including SANParks, operating as an African-centered community of practise for the management of social-ecological systems. Insaka 2018 took place in the Kruger National Park, and was attended by 41 delegates, representing 30 different institutes, across 4 countries. The 2018 conference theme encompassed green infrastructure, "a strategically planned network of natural and semi natural features that spans from wilderness areas to green roofs, targeting both urban and rural areas" (www.europarc.org/). Pairing investment in both green and ecological infrastructure ensure current, and enable future re-establishment of, landscape connectivity, including social connectivity and cohesion. These different types of connectivity are required to optimise the flows of services on which all species depend. Of the 33 presentations, the two keynotes highlighted inspiring examples of (1) the roles of networks and connectors in water governance and their long-term sustainability (Olifants River case study; presented by Sharon Pollard, AWARD) and (2) the connections between transboundary conservation, green infrastructure and local communities in the context of the Kavango-Zambezi Transfrontier Conservation Area (presented by Robert Hitchcock, University of New Mexico). Further presentations covered a range of broad themes within the ambit of green and ecological infrastructure, including rehabilitation, strategic design and practice, sustainable use, stakeholder support and governance. Final comments made a call for more radical social-ecological transformation that entails thinking smarter, larger, faster and more connected in order to really elicit transformation.

Insaka 2018 delegates at Mopani rest camp in Kruger focussed discussions on green infrastructure. © Anonymous

Sam Ferreira

Tercia Strydom

Scientists breaking a sweat at writing "boot camps"

What is the problem?

Why is it important?

What are you doing about it?

These are not the thundering shouts of a corporal on a parade ground, but rather a neat way to conceptualise and write up research findings. These questions form the basis of a well structured scientific paper and are tackled on Day one of writing bootcamps, and as simple as they seem, really makes scientists interrogate their findings and its applications. After surviving scrutiny of the academic problem and justifying its importance to colleagues, boot-campers have to illustrate these findings with graphs and tables, on Day two, explaining how they got their results. Methods and results drafted, a concise introduction outlining the three questions wrestled with on day one is added. Day three is Discussion day – with boot campers identifying key patterns in their results, noting down all likely explanations and interpreting these in the context of published literature. Having gone through the bulk of the paper, bootcampers are finally rewarded by a sundowner in a beautiful locality which helps to wind down and stimulate further reflection. By Day four, boot campers have draft manuscripts that are then peer-reviewed amongst the group. Comments to authors are face-to-face, allowing adaptation, correction and clarification (and arguing) by late afternoon.

After three writing retreats and six formal writing boot camps in two years, the 19 boot campers have published six papers (some featuring in this report) and submitted five manuscripts. For some colleagues this was their first paper, with many more to come. Bootcamps are therefore proven a useful approach to getting dedicated and focused time to turn research data into manuscripts.

Scientific Services colleagues at a writing "boot-camp" enjoying the luxury of dedicated time, collegial support and lots of coffee as they work on their manuscripts – some working on their first paper ever. © Izak Smit

NEWS AND VIEWS

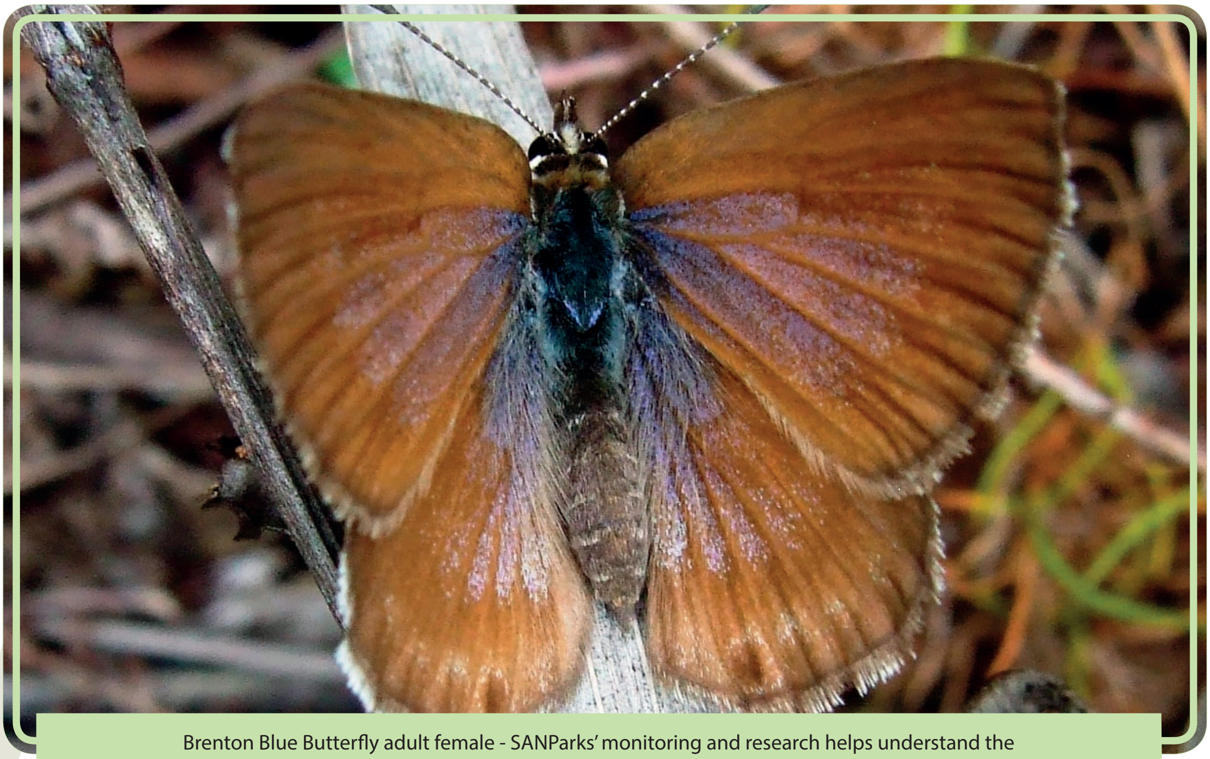
MONITORING

© Alison Kock


Melanie de Morney


Dave Edge

Post-fire Brenton Blue monitoring


Brenton Blue Butterfly adult female - SANParks' monitoring and research helps understand the effect of the 2017 Knysna fires on this critically endangered species. © Justin Bode

The Brenton Blue butterfly is a Critically Endangered South African endemic found only in the 1.6 hectare Brenton Blue Butterfly Reserve (BBBR) in the southern Cape. Various ecological factors combine to make this species an extreme habitat specialist and as a result, very sensitive to environmental changes. One such factor is its obligate relationship with *Camponotus baynei* (Bayne's sugar ant). These ants are attracted to the third instar larvae, both by their dorsal nectar organs, which secrete a honeydew-like substance, and by pheromones similar to ant brood. The larvae at that stage feed on the rootstock of their host plant, *Indigofera erecta,* and the ants assist them to excavate around the rootstock and protect them from predators.

The 2017 Knysna fire swept through the BBBR and the impact of this devastating event on the butterfly is unknown. The post-fire recovery of the BBBR ecosystem is currently being monitored, particularly focusing on the ecological requirements of the Brenton Blue. SANParks are monitoring the presence (or absence) of any *Camponotus* ants. Although *C. baynei* has not been recorded at the BBBR since the fire, two other *Camponotus* species have been found nearby, one of which may be a potential alternative host.


Camponotus baynei nest in a rotten log. These ants, an obligate facilitator, are critical for the future persistence of the Brenton Blue butterfly. © Melanie de Morney

Implementing an intertidal monitoring programme for the Greater Addo Elephant Marine Protected Area.

Permanent monitoring sites are marked by installing tagged markers (in orange) using steel bolts. © Cloverley Lawrence

Cloverley Lawrence

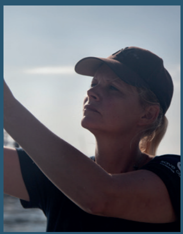
Maya Pfaff

Imtiyaaz Malick

Marine Protected Areas (MPAs) are legally proclaimed areas of coastline and ocean dedicated to the protection and maintenance of natural and cultural features. Although MPAs ensure continuity of key ecosystem services by limiting damaging human activities, their management is often hampered by a lack of resources, resulting in many MPAs falling short of achieving their conservation targets. Through robust empirical programmes that monitor environmental and biological parameters, the effectiveness of MPAs in achieving their goals can be measured while providing vital information to advise management decisions. The recently endorsed Greater Addo Elephant MPA in Algoa Bay is a biodiversity hotspot with high levels of species richness, endemicity and rarity; largely as a result of the many different habitat types and oceanic features that define the bay. A monitoring programme established in collaboration with DEA: Oceans and Coasts and the South African Environmental Observation Network (SAEON), aims to determine spatio-temporal variability in biodiversity, as well as monitor the effects of alien species, pollution, harvesting and climate change on intertidal rocky shores within and outside the MPA. Permanent markers were installed at Cape Padrone east and west (within) and Canon Rocks east and west (outside) as well as at two sites on Bird Island (within). Over time these data will aid in determining the effectiveness of the Addo MPA in conserving intertidal rocky shore diversity.

In order to measure biodiversity (mainly invertebrates and seaweed) in intertidal zones, photographs are taken at every meter mark within a 30 x 30 cm frame, beginning at the high shore and moving towards the sea. © Cloverley Lawrence


Sisanda Mayekiso


Alison Kock


Ndiviwe Baliwe

Initiation of linefish and shark monitoring in West Coast and Table Mountain Marine Protected Areas

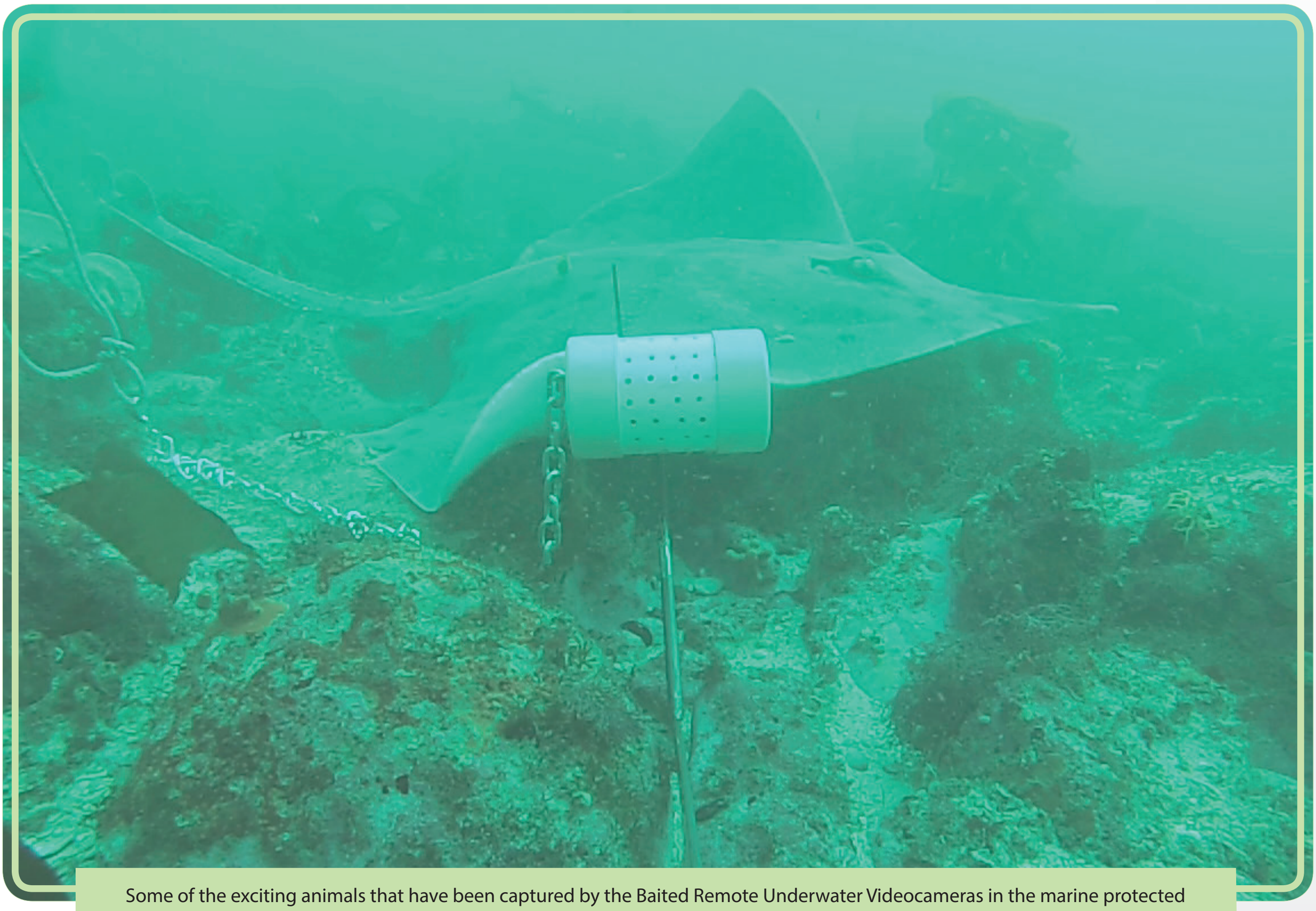

Scientific Services and park staff deploying a Baited Remote Underwater Videocameras (BRUVs) inside the sanctuary area of West Coast National Park during calm sea conditions. © Alison Kock

Oceans face increasing pressures from legal and illegal fishing, climate change, alien species and pollution. Marine Protected Areas (MPAs) are widely accepted as the principal means by which marine biodiversity and exploited species can be conserved and managed on a sustainable basis. It is therefore important that the performance of MPAs is monitored consistently and regularly.

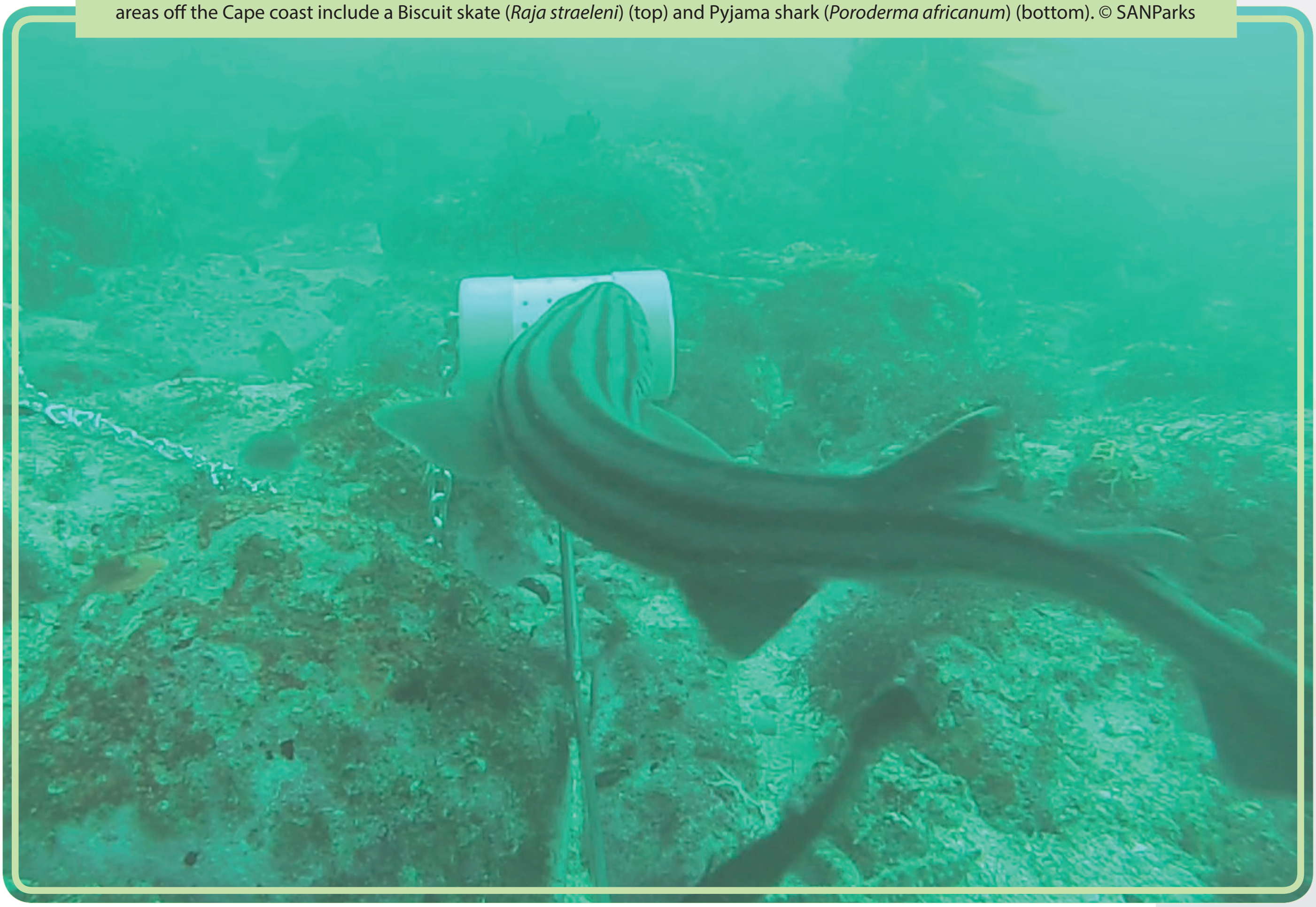
Baited Remote Underwater Videocameras (BRUVs) offer a non-destructive and cost-effective monitoring tool which is frequently used along the South African coastline. In 2018, Scientific Services in collaboration with park management and external researchers from the University of Cape Town and the South African Environmental Observation Network (SAEON), initiated a long-term monitoring program using BRUVs in Table Mountain and West Coast National Parks. Ecological monitoring priorities include determining the status of threatened and commercially important linefish and elasmobranchs.

The teams thoroughly enjoyed analysing the videos captured during the first deployments, which showed a diverse array of inquisitive species and a truly spectacular underwater world. Monitoring will take place bi-annually in these two parks, in restricted and controlled zones of the MPAs. Results will be used to inform improved planning, justifying additional or different resource allocations, and to promote accountability with regard to management effort and outcomes.


Baited remote underwater video-cameras (BRUVs) being prepped by CRC and park staff for deployment in the West Coast National Park to monitor linefish and shark diversity and abundance. © Alison Kock



Some of the exciting animals that have been captured by the Baited Remote Underwater Videocameras in the marine protected areas off the Cape coast include a Biscuit skate (*Raja straeleni*) (top) and Pyjama shark (*Poroderma africanum*) (bottom). © SANParks



SASSing in Table Mountain National Park - getting to know freshwater invertebrates

Ruth-Mary Fisher

Trevor Adams

Freshwater macroinvertebrate biomonitoring was reinstated in Table Mountain National Park in 2018 by Scientific Services using the South African Scoring System (SASS-5), a biomonitoring tool used widely in the country to assess ecological health of rivers. The monitoring was formerly undertaken by the Department of Water and Sanitation and the City of Cape Town as part of their monitoring programmes up until 2016.

Preliminary data analysis was done for the autumn season (April and May) for 2010, 2014, 2018 and 2019 for the Silvermine River at one site. During 2010 and 2014 (data points 1 and 2, Fig. 1) sampling suggested that the river be classified as a D class, which means the river was in a poor, largely modified state. The 2018 and 2019 surveys (data points 3 and 4, Fig. 1), however, suggest an improvement in the state to a C class, which means the river is in a fair, moderately modified state. The monitoring will continue to determine the long term ecological health of the river and possible reasons for the change in status.

©Zishan Ebrahim

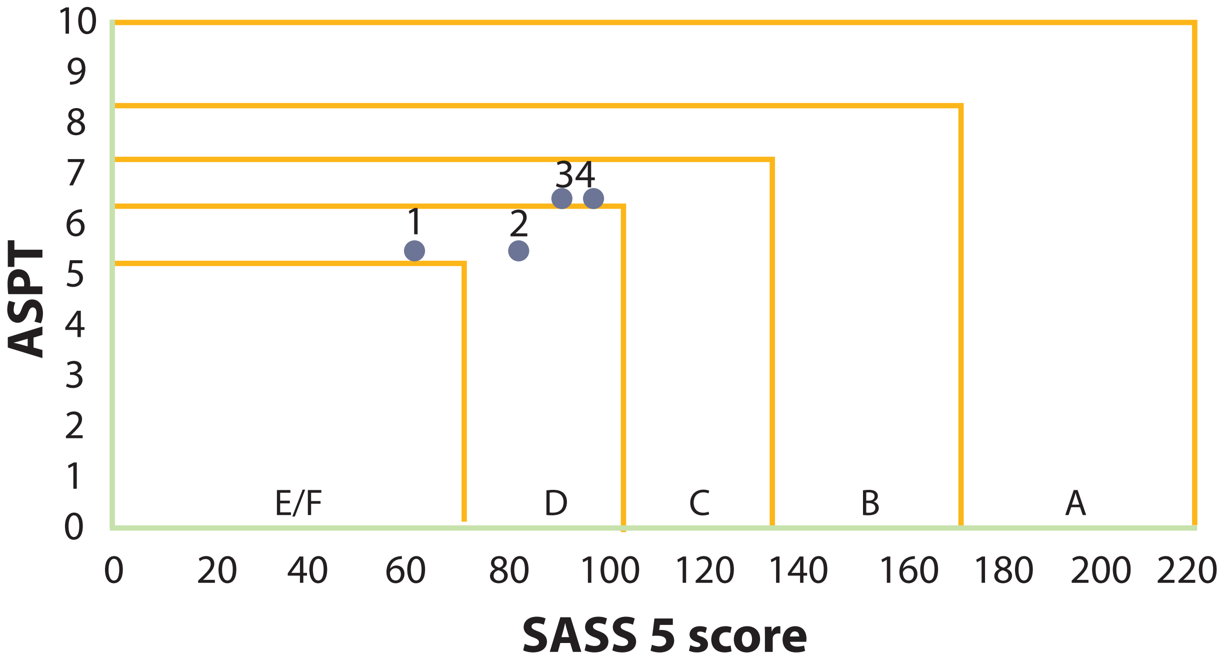


Figure 1. River health monitoring for the Silvermine River at the Sunbird Centre. Data points 1 and 2 data were received from the City of Cape Town (13 May 2014 and 28 April 2010 respectively) while data points 3 and 4 data were collected by SANParks staff (02 May 2018 and 16 April 2019 respectively). Ecological status is inferred using the biological bands determined for the upper zone of the Southern Fold Mountains based on the Average Score Per Taxon (ASPT) and SASS score.

Ruth-Mary and Trevor SASSing in the Cape Rivers © Jonathan Plaistowe.

Mapping and indexing the cumulative urban threat to amphibians within the Table Mountain National Park

Zishan Ebrahim

To determine the threat status of species, information on population sizes are needed. However, for many small animals, and for most plants, population sizes are difficult to measure. As a result threat status is inferred using proxies of threats, such as fragmentation of natural areas and decline/fluctuations of habitat quality. However cumulative threats within a species' range are often not explicitly considered. My MSc study undertook to spatially define several classes of threats, adapted from the threat-scores used by the International Union for Conservation of Nature (IUCN). All seven IUCN spatially-explicit threats (e.g. roads or agricultural footprints) as well as two pervasive threats (alien species and changes to the fire regime) were scored for amphibians and summed for each 5x5m cell covering the Cape peninsula (Fig. 1). Climate change has been overlooked as a threat to date due to the inappropriate scale at which information is available. Results imply that the Red List status of amphibians does not necessarily reflect the cumulative threats faced by individual species, but rather reflects a population size estimate. The threats identified for frogs impact how effective protected areas are in conserving amphibians in the face of increasing urbanization.

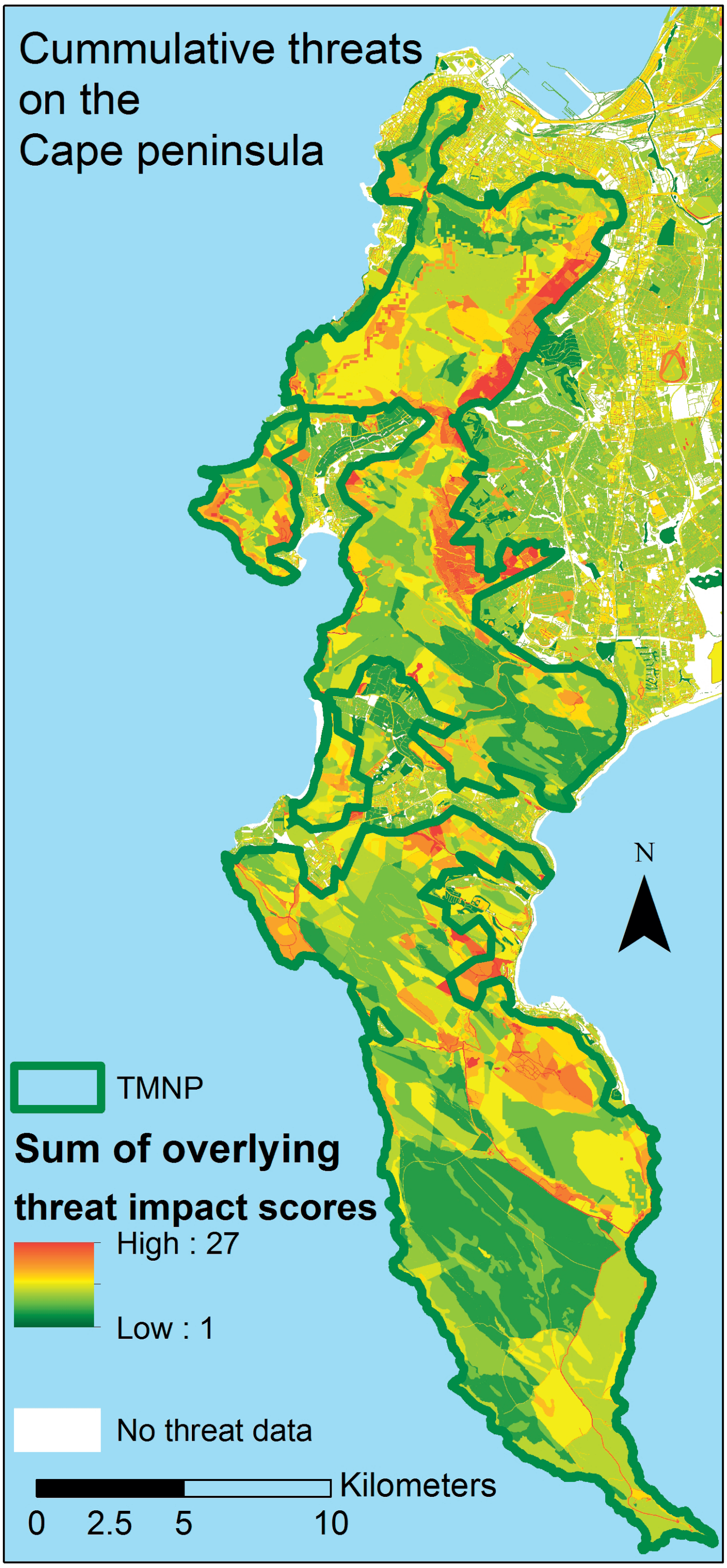
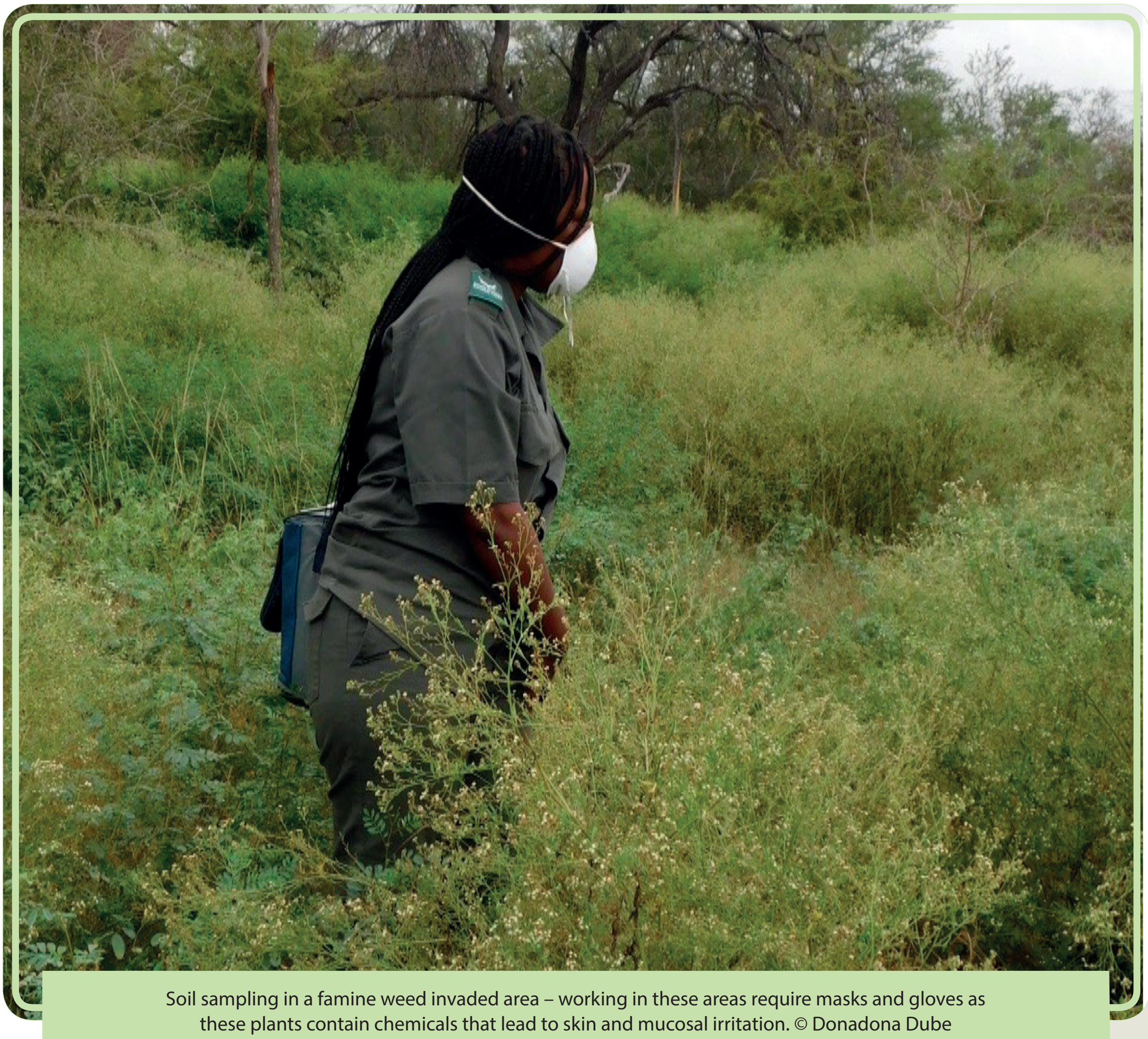


Figure 1. Threats faced by amphibians on the Cape Peninsula have been scored within nine categories by the IUCN. This map shows the cumulative presence of each of these nine threat categories based on their geographic distribution.

Assessing ecosystem impacts of famine weed *(Parthenium hysterophorus)*

Thembeka Thwala

Parthenium hysterophorus, commonly known as famine weed, is native to tropical America but is currently one of the most threatening alien invasive plant species in Kruger National Park. Famine weed is an annual herbaceous weed that invades disturbed areas, road verges and riparian areas. By comparing invaded and non-invaded areas, SANParks scientists, in collaboration with the University of Venda and The Czech Academy of Sciences, are studying the impact that famine weed have on ecosystems, including soil nutrients, soil enzyme activities and the overall impacts on growth rates of native plants. Glucosidase, urease and phosphatase will be analysed to understand soil enzyme activity, which drives the carbon, nitrogen and phosphorus cycles. The study will also investigate possible allelopathic impacts of famine weed by comparing the growth rate of fever trees (*Acacia xanthophloea*) and lettuce (*Lactuca sativa*) experimentally. Finally, the impact of famine weed on certain groups of invertebrates is being studied through the use of pitfall traps. With this study, we hope to gain a better understanding of the negative widespread ecosystem impacts caused by famine weed, which makes the control of this weed imperative.



Soil sampling in a famine weed invaded area – working in these areas require masks and gloves as these plants contain chemicals that lead to skin and mucosal irritation. © Donadona Dube

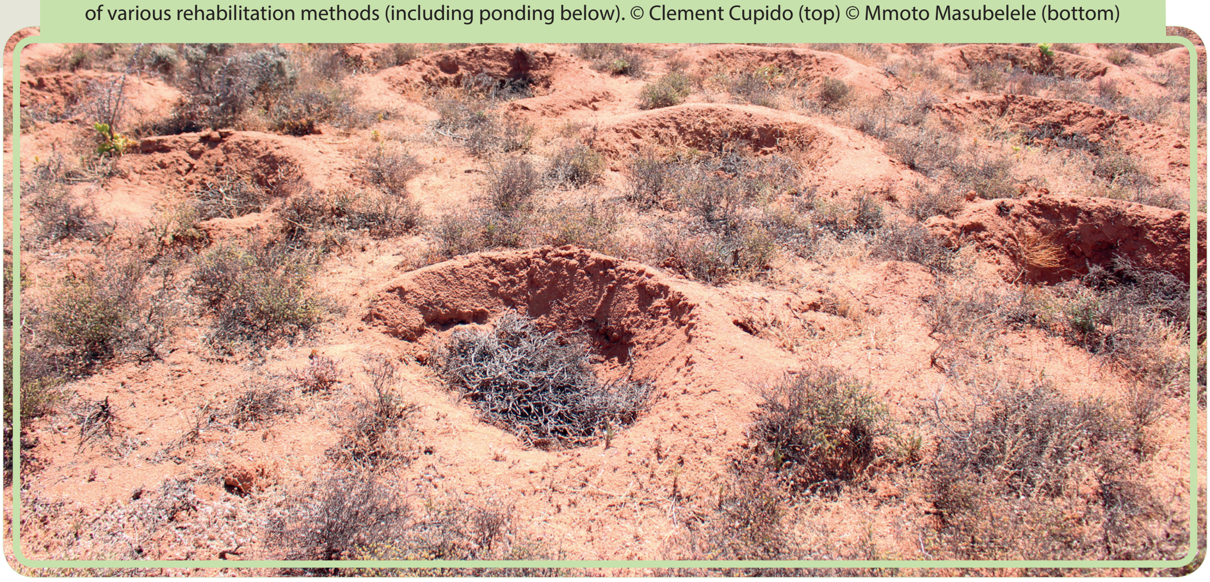
Mmoto Masubelele

Monitoring land degradation and restoration efforts using landscape function assessment

Desertification in arid regions commonly results when land is degraded through a combination of drought and incompatible land use practices. In 2018, a Degradation and Rehabilitation Framework was finalized for the organisation, which provides an overarching framework across parks through which degradation and rehabilitation efforts are assessed and monitored. SANParks contributes substantially to national targets for rehabilitation of degraded land but monitoring tools to gauge rehabilitation success are poorly developed. Landscape Functional Analysis (LFA) has been suggested as a useful tool to understand and assess the complexities of ecological rehabilitation. Vegetation patches, interpatches and soil conditions are determined to indicate landscape functionality. The technique was initially used at Camdeboo and Addo Elephant National Parks, and has since been expanded to other parks.

A total of 11 transects have been established and surveyed in Namaqua National Park since 2014. These cover two rehabilitation treatments, namely ponding (in micro-catchments) and shading (using silt trapping nets), as well as reference sites that resemble near-pristine conditions. Treatments seek to trap seeds, water and nutrients, and slow down run-off. Initial surveys were conducted in collaboration with researchers from University of the Western Cape prior to the 2015/2016 drought, which also provided an opportunity to determine how drought impacts restoration efforts. Preliminary results after the 2017 surveys support ponding as an effective restoration method, despite the severe drought conditions.

The resurvey of a landscape functional analysis assessment with collaborators in Namaqua National Park to establish success of various rehabilitation methods (including ponding below). © Clement Cupido (top) © Mmoto Masubelele (bottom)

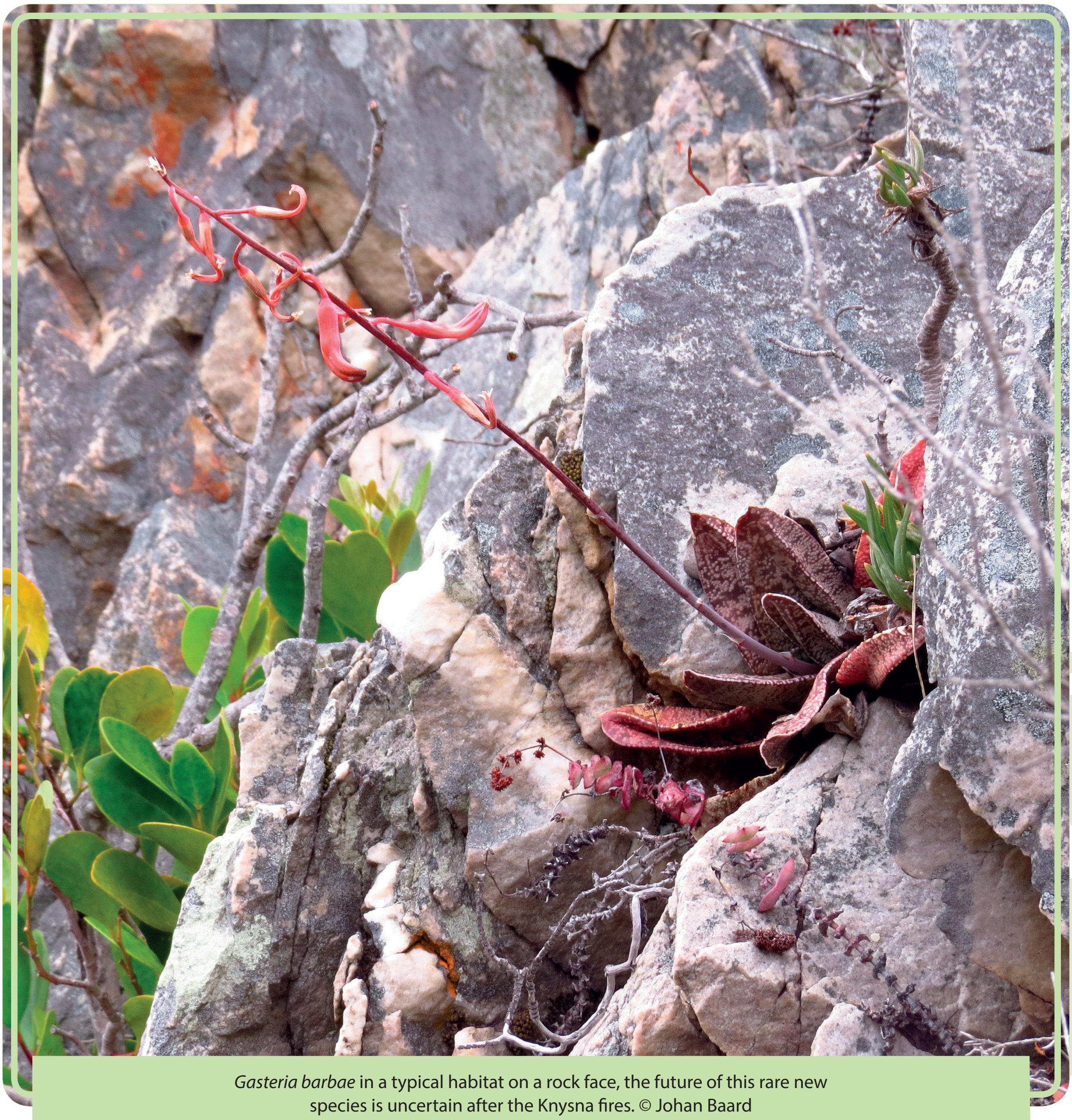


Gasteria barbae, here today, gone tomorrow?

Gasteria barbae (Harkerville Gasteria) was first discovered in March 2010 while searching for *Bulbine latifolia* (rooiwortel) populations. The search took place in Harkerville, 15 km east of Knysna, close to the sea in steep rocky fynbos. I saw a smallish aloe-like plant in a humus filled crevice and as most plants in this habitat are stunted, I thought it may be a stunted *Gasteria acinacifolia* or *Gasteria polita,* the two species of *Gasteria* common in the area. This *Gasteria*, however, was much smaller than *Gasteria acinacifolia* which is associated with dunes, and *G. polita* is also larger, and occurs further from the sea. The locality may have given rise to a smaller, hardier growth form and as no flowers could be found, there was some uncertainty whether this may be a new species. As the area is remote, the population was visited infrequently, but in 2013 I found a second population in flower 5 km from the first. The strange-looking *Gasteria* was brought to the attention of expert, Ernst van Jaarsveld, in 2013. In May 2016 I heard from Ernst that it was indeed a new species and named after me; *barbae* is Latin for Baard!

The 2017 Knysna fire swept through both *G. barbae* locations. After several site visits, eight individual plants were found in one population and none in the other. *Gasteria barbae* is a species that could have disappeared from nature before it could even be described and the future of this little plant is uncertain – maybe it will rise yet again as a phoenix from the ashes.

Johan Baard



Gasteria barbae in a typical habitat on a rock face, the future of this rare new species is uncertain after the Knysna fires. © Johan Baard

Reference: Baard, J.A., 201812. Gasteria barbae: here today, gone tomorrow? Veld & Flora, December 2018, pp 179-181

NEWS AND VIEWS

SOCIETAL ENGAGEMENTS

Science Outreach at Garden Route Scientific Services

Melanie de Morney

Daniëlle Seymour

Learner looking at insects under the microscope during the "Take a girl child to work" event. © Melanie de Morney

Public outreach is becoming increasingly important within the scientific community, especially as environmental problems are growing at an alarming rate and most often involve people. Although outreach is not a core responsibility of Scientific Services, our group recognise that it is critical for making research and monitoring effective and relevant, and in having the most impact for conservation as a whole. Garden Route Scientific Services' biotechnicians and interns conducted and participated in various science outreach events during 2018. Various aspects of biodiversity and conservation were covered through presentations and practical lessons. Age groups ranged from crèche kids to octogenarians; these groups were engaged in events like 'Scientist for a Day', 'Wonderbags and Living Green', 'Kids in Parks' and 'Young Women in the Workplace'. Practical activities (e.g., learners collecting ants and looking at them under microscopes or conducting MiniSASS) were especially enjoyed by the young learners, as they got the opportunity to actively participate in hands on observations and be in touch with nature.

Learners catching macroinvertebrates and conducting a MiniSASS during SANParks Week's 'Scientist for a day' program. © Melanie de Morney

A longitudinal overview of people related research outputs in SANParks – papers and registered research projects

Scientific, evidence-based conservation has a long history in SANParks, being formalised through the establishment of a research department in the 1950's. However, as the focus of conservation moved beyond park boundaries, so too has the focus of research, expanding to increasingly incorporate science that includes people. Not only does society receive benefits from the conservation of biodiversity within parks, but they too are the main driver behind many of the threats facing biodiversity today. For the last 15 years, SANParks has been cultivating the social science function within the organisation. This has led to an increase in research outputs including both numbers, and types of research projects that have a people-component to them (Fig. 1). The amount of papers published as well as the thematic scope of peer reviewed papers that have a people-component has increased in the last 15 years. More recently, the organisation has furthered the integration between science and management, as well as between the social and biophysical science realms, with traditionally ecological scientists conducting far more integrated and interdisciplinary work. This has not only expanded the internal capacity for social science, but provides for a more robust context to address research on broader sustainability themes that cross-cut social, ecological, economic and political realms, under ever-present resource constraints.

Research with a people component includes research that either uses social science research methodologies or that focuses broadly on the interactions between people and the natural environment (e.g. resource use, human wildlife interactions, conservation employee wellbeing).

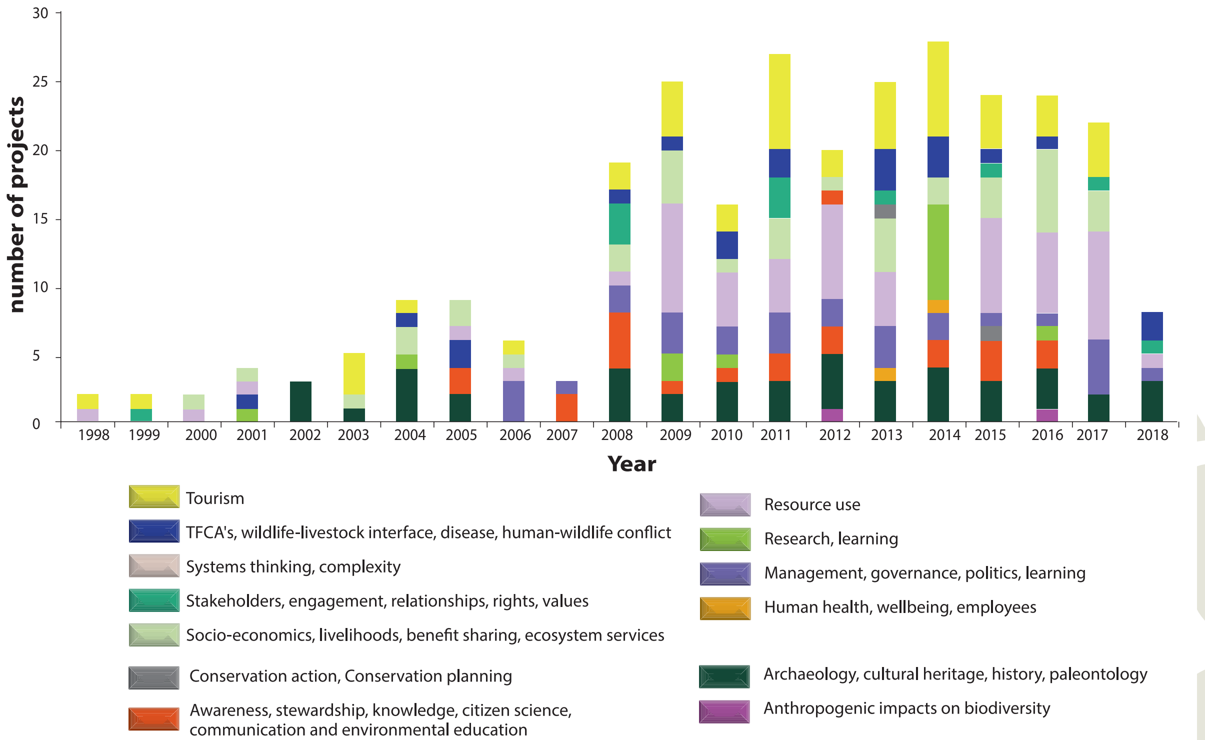
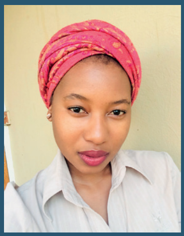


Figure 1. Research projects with a people component registered annually in SANParks.

Louise Swemmer

Izak Smit



Samantha Mabuza

Judith Botha

Nerina Kruger

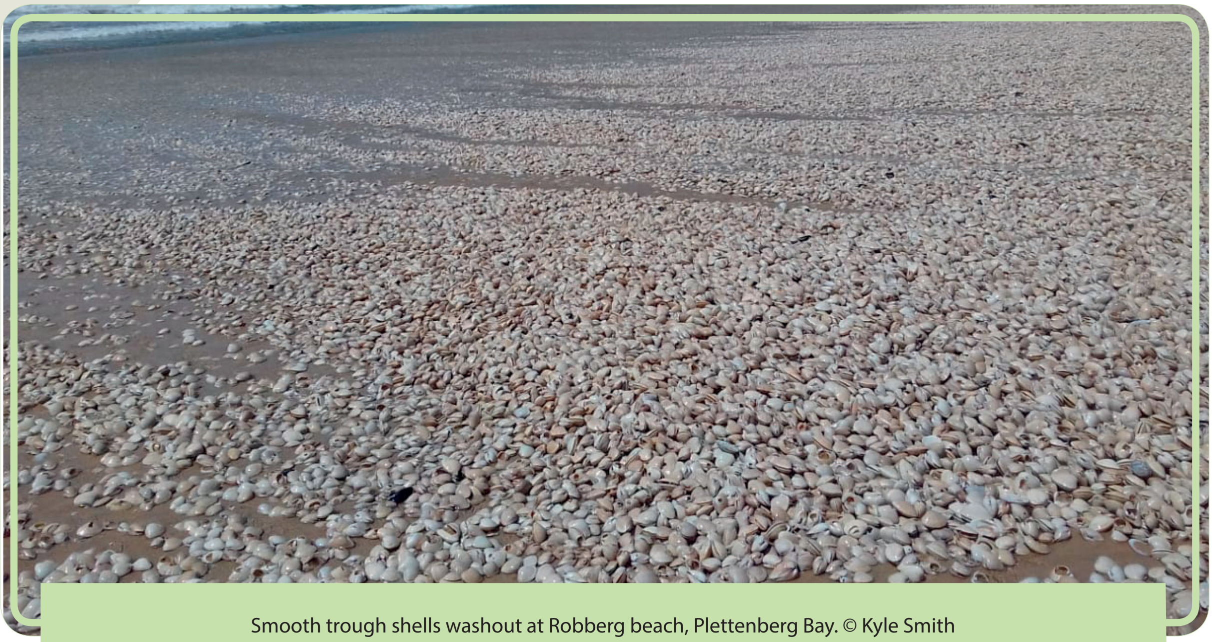
Deborah Winterton

Kyle Smith

Monitoring unusual and sporadic beach washout events along the Garden Route coast

Natures Valley Intern Hannah Basson and SANParks Marine Ecologist, Kyle Smith setting up belt transects. © Gwenith S Penry

Mass washout events of invertebrates and fish species occur intermittently along our beaches. Until fairly recently these events may have gone relatively unnoticed. However, today such unusual events are quickly advertised through various online media platforms. During 2018, we started to monitor these events more formally in the Garden Route by collecting information such as times, dates, localities and extent of the events. In particular we wanted to obtain estimates of total abundance, biomass and size classes of species involved. To date two major clam washout events have been covered in Plettenberg Bay. The first washout was restricted to an area near the Keurbooms River mouth, whilst the second occurred near Robberg. The survey provided some surprising results. The smooth trough shell (*Mactra glabrata*) was the main species involved although a few venus clams, otter shells and furrowed horse mussels were also found. From replicate belt transects it could be estimated that during the first event 91 400 clams washed out with a total weight of about 3 tons, whilst the second event was much larger with an estimated 11 million clams and a total weight of around 400 tons. The cause and ecological significance of these events remain an enigma for now.

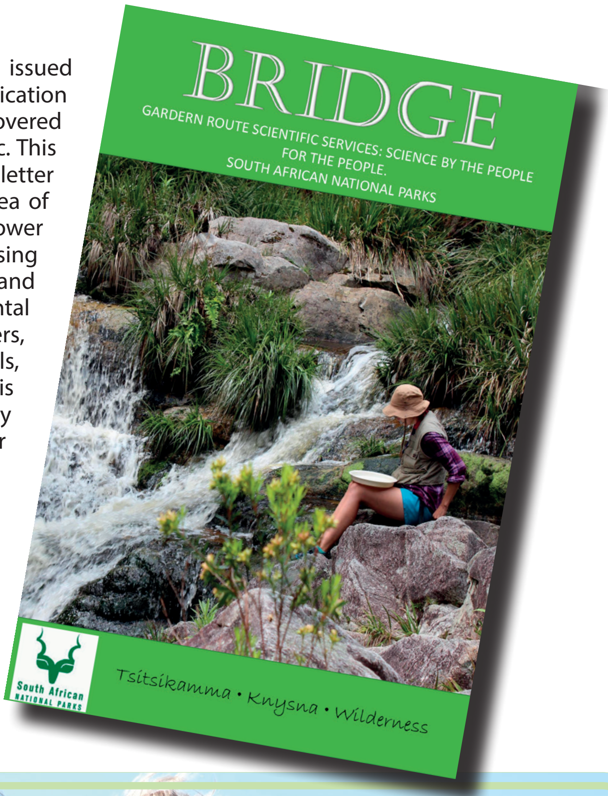


Smooth trough shells washout at Robberg beach, Plettenberg Bay. © Kyle Smith

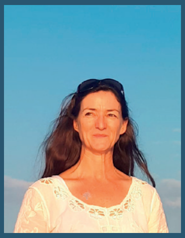
Bridging the gap between scientists and the public - a journey to making science popular

Nelsiwe Mpapane

A White Paper on Science, Technology and Innovation issued by government in March 2019, addresses the communication gap between science – what is being studied and discovered in universities and research laboratories – and the public. This provided great impetus for the launch of The Bridge newsletter in the Garden Route. "The Bridge" was born from an idea of communicating science as a tool to connect and empower greater society. SANParks are faced with many pressing environmental issues, especially at community level, and scientists are grappling with ways in which environmental and conservation messages are relayed. Scientific papers, many of which are published in subscription journals, marginalize a large group of people in society and is perhaps not the most inclusive and approachable way that science can be communicated. The Bridge newsletter aims to reach individuals from different backgrounds by presenting research stories by SANParks scientists in the Garden Route in a popular and more engaging way. This newsletter is a stepping stone to other forms of engagements with society. There is still much that is being planned to bridge the gap with the public and ultimately contribute to a positive image of science.



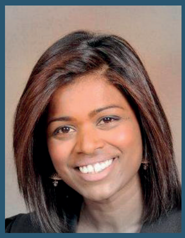
Nelson Mandela University students enjoying the latest edition of 'The Bridge'; a publication that is trying to make science accessible and interesting to all. © Neliswe Mpapane



Louise Swemmer

Sam Ferreira

Izak Smit



Danny Govender

Danie Pienaar

Stephen Midzi

Scientists and guides share information to inform visitor engagement and research

In July 2018, SANParks scientists held two science days with guides working throughout the Kruger National Park (Kruger). These aimed to facilitate information-sharing and discussion on topical conservation issues pertaining to Kruger. The attendees included trails guides, camp guides, camp managers and duty managers representing 16 main camps, bush camps and gates, three wilderness trails camps and a small number of People and Conservation staff, students, scientists and honorary rangers (Fig. 1). In depth discussions focussed on issues of elephant management and freshwater resources and droughts in Kruger. Benefit sharing, resource use and diseases such as malaria were also briefly covered. A consolidated report of discussions together with a Q&A document will provide reference material for guides going forward. Overall, both scientists and guides responded positively to the engagement with all guides indicating that the knowledge gained from the discussions will be of benefit in any future interactions with guests. All guides indicted that they would like to participate in more of such engagement events. Based on feedback from the guides as well as public interests addressed over social media, suggested topics for future sessions could include resource use, disease, poaching, census techniques and the latest fire policy. With 1.8 million people arriving at Kruger's gates in 2018, reaching a small group of tourism guides and trails rangers with more in depth and current knowledge can have an incredible magnifier effect of getting science messages to potentially thousands of tourists.

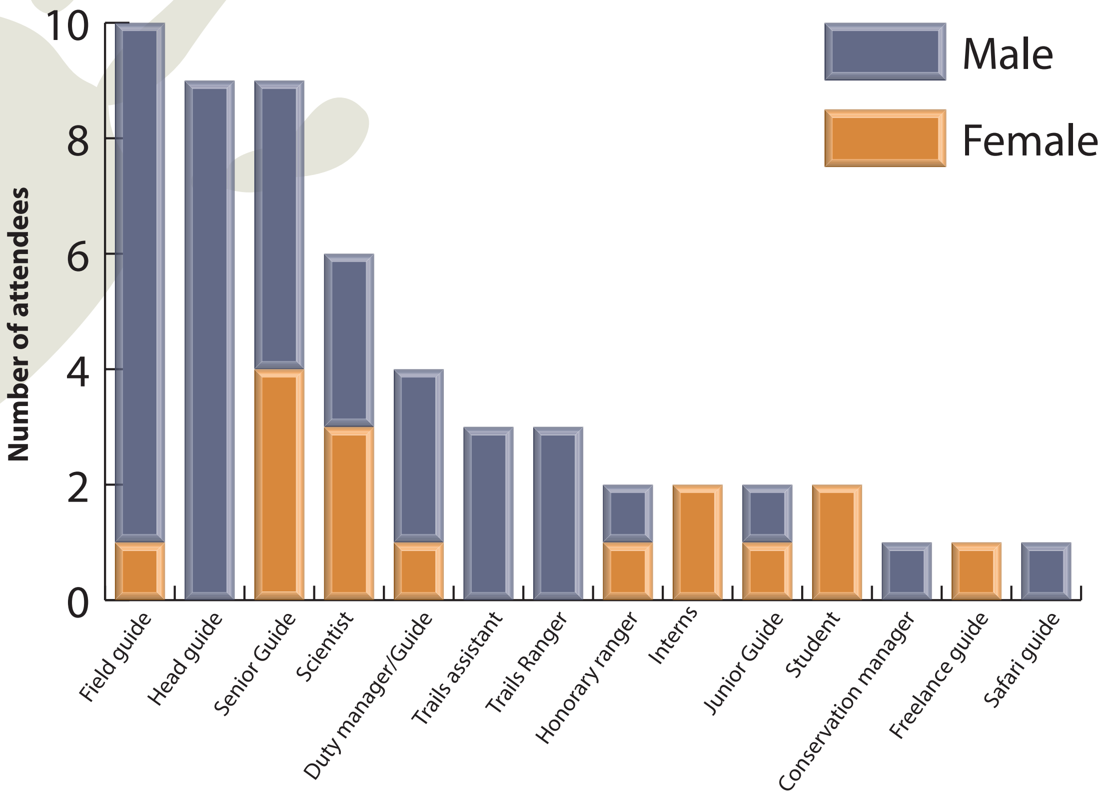


Figure 1. The number of attendees representing various groups within SANParks, who attended the Kruger National Park science-guide days in July 2018.

Scientists and guides engage on issues of elephants, water, resource use and disease at Letaba Camp, Kruger National Park. © Louise Swemmer

Science presentations in Skukuza camp, Kruger National Park, stimulating discussions with scientists and guides on topical conservation issues. © Louise Swemmer

Cooperatively imagining the desired future state of parks with stakeholders in the Garden Route


Stefanie Freitag-Ronaldson


Dirk Roux


Megan Taplin


Sandra Taljaard


Peter Gordon


Nandi Mgwadlamba



Two Tsitsikamma workshops with diverse stakeholders highlighted the strong sense of place, belonging and attachment felt by these communities to the places where they live. Photo Left © Stefanie Freitag-Ronaldson; Photo Right © Peter Gordon

Seven workshops in six weeks with diverse stakeholder groupings in the Garden Route during April-May 2018! Here people talked openly about their dreams, aspirations and joint vision for the Garden Route and its national park "to be an innovative and accessible national park, spanning mountains to marine, conserving the natural and cultural heritage of the Garden Route collaboratively for the benefit of people and the environment".

Assisted by facilitators Sonja Blignaut and Bianca Currie, the adaptive planning outcomes reflect nuanced voices of diverse communities across Tsitsikamma, Knysna and Wilderness. Notwithstanding differences in backgrounds and expectations, core values converged to four broad classes: ethics and how we act, engaging and communicating with each other, governance and management approaches, and sustainability outcomes.

Key emergent issues include access and accessibility, particularly by locals and economically marginalised people. There were strong calls for the park to play a role in connecting people to the environment/nature, especially in educating and re-connecting the youth. Discussions highlighted requirements to effectively cross administrative boundaries to enable landscape functionality and, with this, multiple outcomes for conservation, livelihoods and the local economy. The need to show leadership in environmental/green practice was a recurring theme as was the reiteration to "really live our values".



Visioning with the Touwsranten community, with strong engagement of the youth who articulated that this is a clean, scenic and beautiful area with a naturally calming effect on people and visitors. © Dirk Roux

TECHNOLOGY BRIEF/ EQUIPMENT

© Laurence Kruger

Developing a novel method for collecting and preserving plant metabolome for biochemical and functional characterization

Ilya Raskin

Sarah Skubel

Llewellyn Foxcroft

As sessile organisms, plants are entirely reliant on the compounds they produce to defend and sustain themselves. Plant metabolomics is the investigation of these compounds. All compounds together create metabolomic profiles, the study of which is hampered by the lack of efficient methods to measure diversity of phytochemicals. In collaboration with scientists from Kruger National Park, researchers from the University of New Jersey have developed a RApid Metabolome Extraction and Storage (RAMES) technology that allows compact and field-deployable collection and stable storage of metabolomic libraries. Just two grams of plant tissue extracted in ethanol produces 25-35 glass fibre discs impregnated with phytochemicals. The compounds can then be biochemically characterized or used directly in assessing, for example, anti-microbial, anti-parasitic and anti-oxidant properties. Extensive testing confirmed that RAMES libraries exhibit minimal degradation of compounds after a year of appropriate storage. Using RAMES technology in combination with liquid chromatography and high resolution mass spectrometry, we confirmed the hypothesis that populations of three invasive alien plant species collected at KNP (*Chromolaena odorata, Datura stramonium,* and *Xanthium strumarium*) exhibit significant metabolomic divergence from their native populations in the United States (US). South African samples have greater phytochemical diversity and contained compounds not present in the US populations. This observation suggests that successful invasive behaviour may result from biochemical adaptation to a novel environment and proves the value of the technique in answering important ecological questions on suitably banked material.

Sample preparation by Sarah Skubel, with SANParks collaborators Llewellyn Foxcroft and Thembeka Thwala. © Ilya Raskin

"FREEZING" PLANT PHYTOCHEMICALS IN TIME - FOUR EASY STEPS

STEP 1

Two gram sample of plant tissue

STEP 2

Dremel tool to grind plant material

STEP 3

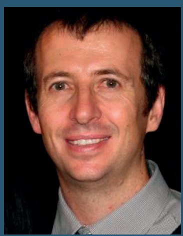
Extract phytochemicals with ethanol, transfer to glass fibre discs and dry

STEP 4

Store glass fibre discs until ready to do phytochemical assays

Photos reproduced from Skubel et al. 2018.

S.A., V. Dushenkov, B.L. Graf, Q. Niu, A. Poulev, H.M. Kalariya, L.C. Foxcroft and I. Raskin. 2018. Rapid, field-deployable method for collecting and preserving plant metabolome for biochemical and functional characterization. PLOS ONE 13(9): e0203569. https://doi.org/10.1371/journal.pone.0203569


Robin Petersen

Gordon O'Brien

Matthew Burnett

Pauli Viljoen

Danie Pienaar

Remote tracking of fish and crocodiles in the Olifants River Gorge, Kruger National Park

The Olifants River is heavily compromised due to adverse anthropogenic activities. There are increasing signs of these impacts, most notably the mass mortality of Nile crocodiles and fish during 2007/2008. SANParks, in collaboration with the University of Mpumalanga and the University of KwaZulu-Natal, has initiated a project to characterise the effects of multiple stressors, including pollution, altered flows and habitat destruction, on the behavioural ecology of crocodiles and fish in the Lower Olifants River. The study involves the use of the South African FISHTRAC system (Fig. 1 and see www.wirelesswildlife.co.za for more information) which uses smart radio telemetry devices that are attached to fish and crocodiles. Transceivers send and receive information across a wireless network between sensors and a Data Management System (DMS) which allows for remote monitoring in real time. Two types of aquatic transceiver devices are used in the study, 1) abiotic probes that measure environmental variables such as flow and water quality and 2) tags attached to the fish and crocodiles that are used to locate the animal and monitor its movement (Fig. 2). Once the DMS receives the data it can be accessed in real time via the internet on any device. The DMS can also be structured to carry out some simple statistical analyses, queries, send results and/or alert messages to any mobile device in real time. This information will be used to develop a regional scale, ecological risk assessment of multiple stressors which will assist the management of the Lower Olifants River.


A tag mounted on a crocodile; the tag communicates with a data management system which keeps track of the animal's movement. The project started in April 2018 and 10 crocodiles and 11 fish have been tagged so far (three fish have been predated on by fish eagles in the meantime). © Robin Petersen

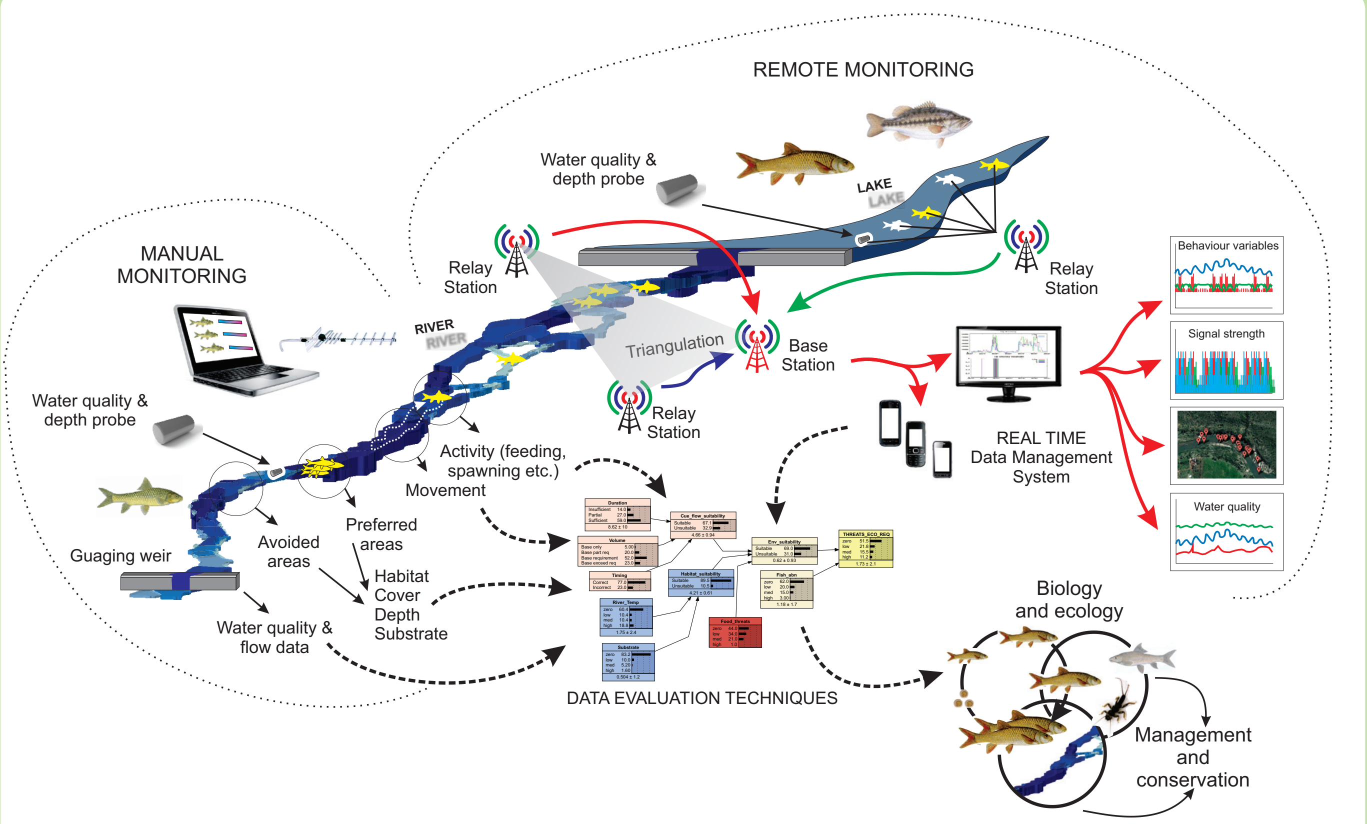


Figure 1. Schematic summary of the FISHTRAC tool used to monitor water quality and flow variables, and the behavioural response of fish to changes in rivers and dams in real time, remotely.

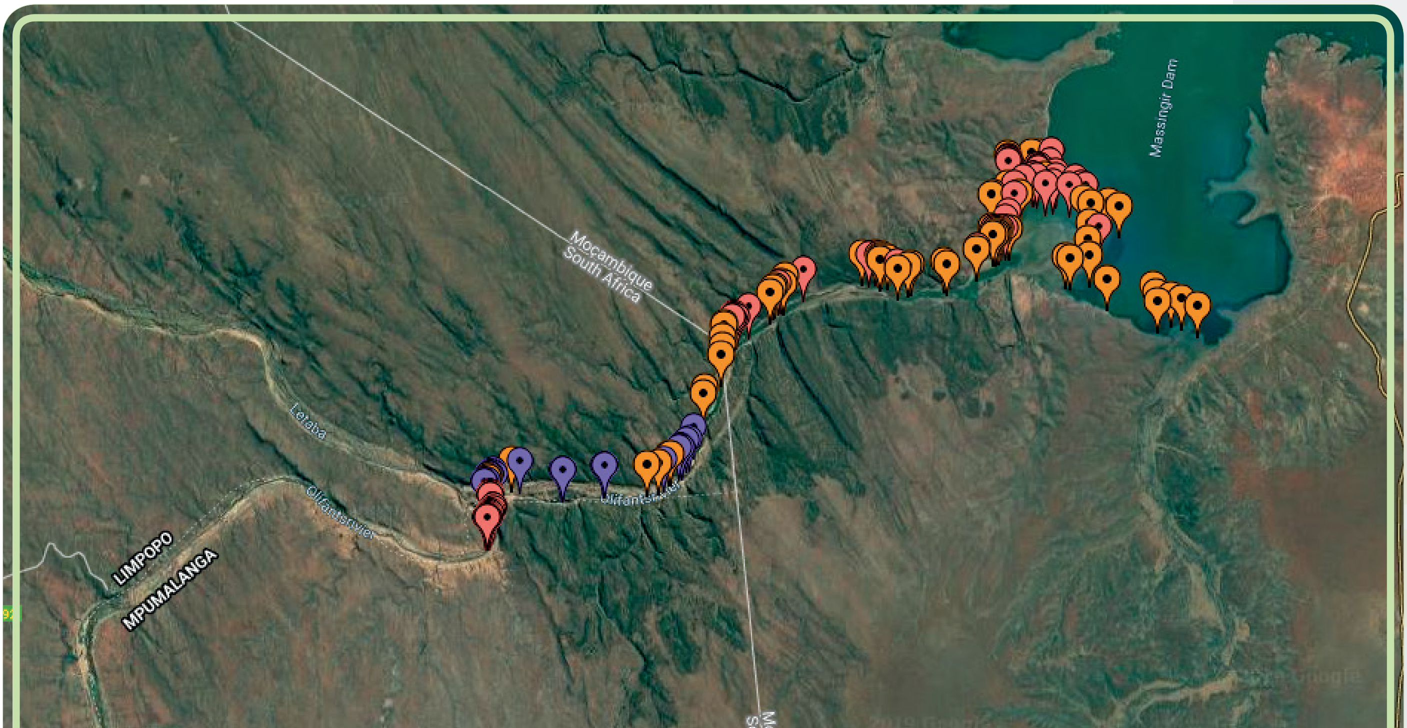
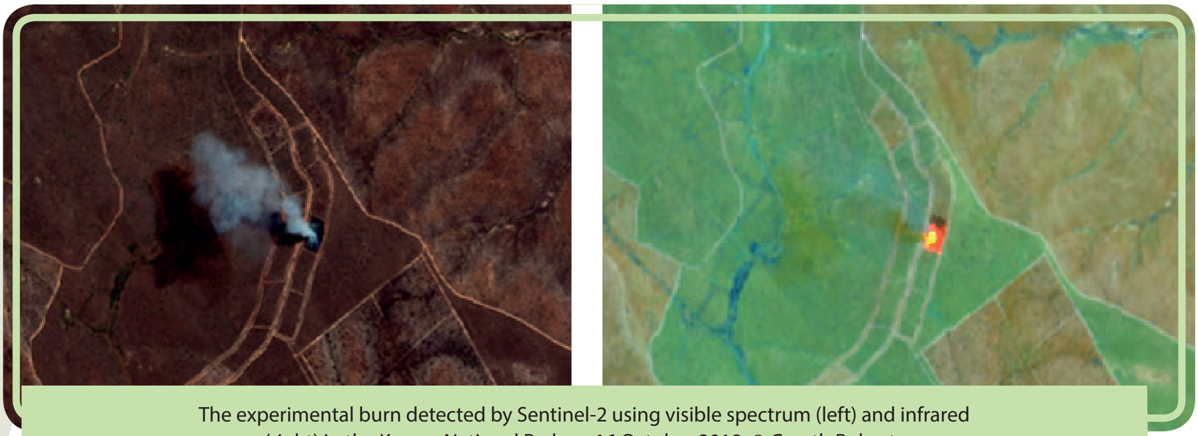


Figure 2. An example of the crocodile movement data from the lower Olifants River displayed on the data management system (DMS) interface; different coloured tags denote the movements of individual crocodiles over a period of about one year.

Tercia Strydom

Ground-truthing fire detections from recently-launched satellites in Kruger National Park

In 2015, the European Space Agency launched Sentinel-2, followed by Sentinel-3 in 2016. Thanks to the state-of-the-art instruments aboard these satellites, fire detections have become a whole lot easier and can be used to improve global fire monitoring and management. As the result of a joint research project involving Prof. Martin Wooster from King's College London, Dr. Gareth Roberts from the University of Southampton, the European Space Agency and SANParks' Scientific Services, fire detections by Sentinel satellites can be validated. Ground-truthing satellite detection and other measurements, such as fire radiative power, allows predictive algorithms on board these satellites to be improved. In order to gather the necessary information, a fire needs to burn as the satellite passes over. The Experimental Burn Plots in Kruger National Park is a long-term fire experiment which was initiated in 1954. Fires are applied on these plots as scheduled treatments with varying frequencies and seasons, which make them perfect to validate satellite detections because vegetation characteristics and weather conditions are known.



The experimental burn detected by Sentinel-2 using visible spectrum (left) and infrared (right) in the Kruger National Park on 16 October 2018. © Gareth Roberts

On 16 October 2018, the Scientific Services fire team managed to ignite two controlled burns on the experimental burn plots just in time for both Sentinel-2 and-3 to detect these fires during their quotidian overpasses. To add to the already complex logistics, a helicopter mounted with a thermal camera had to fly over at just the right moment. Ensuring that the prime of the fire, i.e. when it is most intense, is actively burning as the satellite passes over takes incredible precision. Timing is key –the satellite is only in the correct position for a second!

The Kruger National Park Scientific Services Fire Team, who won a SANParks "Team Award" for their support to fire research in the park, enjoys a moment together with some external researcher collaborators after successfully applying fires at the Experimental Burn Plots. © Stefan Doerr

An experimental fire applied in Kruger National Park was used to validate fire detection by Sentinel satellites. © Tercia Strydom

Member of the Kruger National Park Fire Team extinguishing a burning log on the Experimental Burn Plots. © Tercia Strydom


SCIENCE
STORIES
© Kyle Smith

Sense of Place in the Tsitsikamma: cultural ecosystem services and their role in biodiversity conservation

Conservation has moved from a single-objective discipline focused mainly on biodiversity conservation to a multiplicity of views currently, including the conservation of ecosystem services

Mohlamatsane Mokhatla

The mandate of many protected areas (PAs) has evolved to include the conservation of cultural landscapes in addition to biodiversity. PAs provide many benefits, including cultural ecosystem services, to humans. The feelings and bonds that people have with specific places – their sense of place - and the role these places have in their lives and identities will shape how they experience and manage a place. A deeper understanding of how different groups relate to these spaces can be important in gaining support for conservation.

The Tsitsikamma section of the Garden Route National Park (GRNP) is an interesting place to conduct such research. This section is a very popular tourist destination with spectacular scenery. At the same time, the park is surrounded by fishing communities, who have had a complex history with their environment and their relationship and feelings towards the place are unique. It is only as recently as 2016 that Tsitsikamma residents were granted access to fish in selected control zones (TCCZ 1 to 3; Fig. 1) in the marine protected area (MPA) following a rezoning process. This was preceded by lengthy deliberations between communities, SANParks and the Department of Environmental Affairs to change the conditions set in 2000, when the MPA section was declared a "no-take" zone.

I investigated the sense of place of tourists and communities around the Tsitsikamma MPA in order to untangle the differences between them and to explore how this knowledge can be incorporated into management. Data was collected using questionnaires and semi-structured interviews between June 2017 and November 2018, characterising sense of place using five variables: physical, cultural, social, dependent and ideological. Eighty-seven questionnaires and 50 semi-structured interviews were conducted with tourists and a further 120 semi-structured interviews were conducted with residents of eight communities around the Tsitsikamma section of the Garden Route (see Fig. 1).

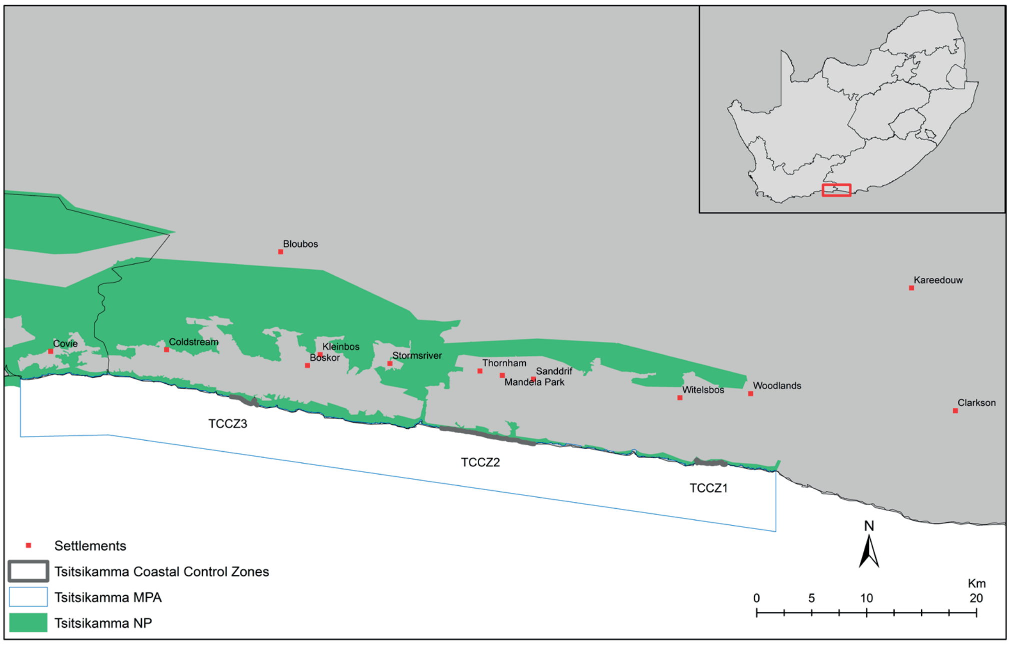


Figure 1. Map of the Tsitsikamma section of the Garden Route National Parks including the surrounding villages.

The data for tourists and residents were analysed separately. Keywords from both tourists and residents were assigned to each variable. Although the biophysical variable was the most prominent for the tourists, the cultural variable stood out for communities, perhaps reflecting their historical connection to the place. The biophysical and dependent variables were the second most important variable for residents, with the ideological variable following closely behind. The ideological variable was second for the tourists. Surprisingly, most tourists were not aware that Tsitsikamma conserved both terrestrial and marine habitats.

Communities tend to have more complex relationships with adjacent PAs than do tourists. For tourists, they may just be a beautiful place to visit, while for local communities they have historical significance and may contribute to providing basic necessities such as water, food, shelter, etc. Managers should look at this multiplicity of objectives to drive pro-conservation support from the different groups, based on what each group values more.

It's not just about the worm - the social and economic impact of harvesting *Imbrasia belina* larvae from the Kruger National Park, South Africa

Facilitating access for local neighbours to harvest sustainable amounts of natural resources from protected areas can contribute positively to participant wellbeing, as well as to relationship building between protected area staff and participants – both contributing towards social relevance and conservation sustainability

Louise Swemmer

Recent work suggests that a net positive impact accruing as a result of benefit sharing from protected areas will build vested interest in conservation, leading to pro-conservation attitudes and behaviours among beneficiary groups, in turn contributing positively to conservation sustainability. However, there are several assumptions that have yet to be tested, before such frameworks can be accepted and applied more broadly in the conservation arena. Our research used a case study involving the harvesting of the larvae of the emperor moth (*Imbrasia belina*) – commonly referred to as mopane worms – from the Kruger National Park (Kruger). We wanted to test whether facilitating access to direct benefits arising from the flow of ecosystem services within a conservation area has a net-positive, measurable impact on human well-being, and secondly if such projects lead to a net positive impact on the conservation estate through building social relevance.

The harvesting of mopane worms in the Kruger National Park is closely monitored, taking place when outbreak sizes are appropriate, and at a scale at which there is predicted to be no long term negative impacts on the natural system. A total of

Focus group in Plange village, Limpopo discussing the social and economic impact of the mopane worm harvesting that takes place from time to time in the Kruger National Park. © Patience Mdungasi

263 people from 16 neighbouring villages participated in the first two seasons of harvesting, 53 of whom were part of this research study. Social and economic impact data were collected through focus groups and semi-structured questionnaires. Harvesters collected a total of 46,881 worms which contributed to 50.3% of their household income during the months of harvest, despite paying ZAR 50 for transport. Most respondents and their families were fearful of wildlife in the park prior to participating in the harvest. However, afterwards, participants felt that they had gained from the experience, feeling that the park was opening up to them, and viewed Kruger differently as a result. For almost 90% of the participants, the project provided their first opportunity to visit Kruger. Respondents perceived their relationship with Kruger to be positive and expressed hope for building on this in the future. However, respondents did indicate that some of their community members felt negative regarding not having been chosen, with type of selection method seemingly playing a role.

On a broader level, participants were mostly content living in their villages, with half of the positive aspects of village life being attributed to the presence of Kruger (e.g. the opportunity to benefit from the park, to see wild animals and to live close to nature). A comparatively small number of negative elements of village life were directly attributed to the Park (e.g. human-wildlife conflict). Most harvesters in our study were female, with some being household heads with no income apart from social grants, suggesting that sustainable resource use opportunities benefit marginalised and vulnerable groups more.

Since the start of the project, harvesting is generally only approved if the mopane worm outbreak sizes are large. This is both to ensure ecological sustainability, and based on the assumption that participants would only want to harvest when they could get a lot of worms, as they also have to pay transport costs to get to the park. However, we have learnt that the positive impacts of participating also included the experience, visiting new places and meeting and engaging with new people, regardless of the financial benefit of the resource harvested. These less tangible, yet positive outcomes should be considered when deciding whether or not to harvest worms based on a smaller outbreak size, provided the harvest does not impact negatively on the ecosystem.

Mopane worms harvested as part of the Kruger National Park Mopane worm harvesting project. © Louise Swemmer

We also highlight that such projects can contribute towards conservation transformation in the context of environmental justice. However, we further suggest that the human-human engagement between groups leads to more positive relationships and in so doing builds "social connectedness" between KNP staff and local community members. This social connectedness has the potential to influence stakeholder perceptions of the role and value of protected areas and to shape their vested interest in conservation which may drive decisions regarding pro- or anti-conservation behaviour.

Mopane worm harvesters from Muyexe Village who participated in the Mopane worm harvesting in the Kruger National Park. © Louise Swemmer

References

Swemmer LK, Mmethi HA & Twine W (2017) Tracing the cost/benefit pathway of protected areas: A case study of the Kruger National Park, South Africa. Ecosystem Services 28: 162 - 172.

Swemmer LK, Landela R, Mdungasi P, Midzi S, Mmatho W, Mmethi HA, Shibambu D, Symonds A, Themba S & Twine W. It's not just about the worm - the social and economic impact of harvesting Imbrasia belina larvae from the Kruger National Park, South Africa. In review.

The case for embedding researchers in conservation agencies

Embedding researchers in conservation agencies can promote knowledge exchange, research relevance, and management effectiveness

Our study supports the ecosystem service framework, specifically in the context of how accessing natural resources as a product derived from ecosystem services flowing within a protected area can have a positive impact on human wellbeing. Although protected areas (PAs) represent a pivotal response to escalating ecosystem change and biodiversity loss, they face many pressures, inside and outside their boundaries. Amid these challenges, effective management relies on dynamic learning processes, including scientific research, and good mechanisms of knowledge exchange, especially between scientists and managers.

Dirk Roux

PAs have enormous potential as strategic research sites, however, relatively few appear to be used as such. Furthermore, research undertaken in PAs, and conservation science more generally, often only modestly contributes to improved management and governance of PAs, with requisite scientific information rarely being accessible to managers in a useful format or at the right time. Reasons for this include that: (a) the incentive structures for academic researchers often mean that management-relevant research is undervalued by external researchers because it can be context specific and perceived to be of local interest; (b) academic researchers tend to focus on larger, older and more accessible PAs with the majority of PAs around the world receiving little or no research attention; (c) a persistent disciplinary bias towards ecological research leaves many social and cultural conservation issues relatively unexplored; and (d) the integrative, systemic (which includes long-term monitoring) and collaborative research required to address important human-nature interactions and the complex feedbacks among system components and across scales is seldom amenable to conventional disciplinary approaches and short-term project funding.

Embedding research capacity in conservation agencies can help to overcome the above impediments and promote "parks for science" and "science for parks". Where embedded scientists exist, they typically represent a small proportion (1-5%) of conservation agency staff. They are permanent employees providing long-term commitment for building networks, trust and social capital among academic and non-academic stakeholders for effective knowledge exchange. Embedded scientists act as skilled gatekeepers who increase the likelihood that priority knowledge needs are communicated to and addressed by external researchers, and that new scientific knowledge is translated and communicated back to decision-makers and stakeholders. Furthermore, they attract, coordinate and support management-relevant external research projects and drive the design and maintenance of long-term monitoring, aligned to management priorities.

SANParks makes use of the embedding model, with approximately 1% of its full-time personnel being researchers. Here, staff representing planning, management and science, visited St. Croix Island that is part of Addo Elephant National Park. Such joint field visits promote shared understanding of ever evolving conservation issues, e.g. to conserve the largest breeding population of the endangered African penguin (on the islands of Algoa Bay) in close proximity to a commercial harbour (Coega) and permitted bunkering (to supply ships with fuel) on the open sea. © Dirk Roux

There are additional advantages to embedded scientists being active researchers. Active researchers can relatively quickly respond to emerging information needs to address even mundane questions with potentially low academic recognition but essential for management. Practicing agency researchers also keep up-to-date with the ever-growing scientific literature in their fields, allowing them to identify relevant research, assess its quality and applicability to management decisions, and translate findings for management. They also synthesize available evidence for policy or management.

Case study evidence from around the world suggest that the most successful embedded research units maintain their scientific credibility through publishing in peer-reviewed journals, attending scientific meetings, and participating in specialized knowledge networks. They collaborate extensively with external researchers, spearhead transdisciplinary approaches to address complex social-ecological conservation problems, serve as bridging agents between learning and doing (e.g. through adaptive management), and advance co-learning and knowledge exchange among scientists, decision-makers and diverse stakeholders. Notwithstanding many benefits, research capacity of conservation agencies is declining across the world, being increasingly vulnerable to budget cuts and restructures. A significant challenge is that the values, structures, functions and effectiveness of the embedded model of knowledge exchange remain poorly evaluated and documented. Also, embedded researchers have to balance their desire for creativity and flexibility with the standardization and quality control required by their public sector agencies; they are not truly independent of their agency and may be perceived as not credible; and they have to couple scientific productivity with skills for transdisciplinary research, social facilitation and stakeholder engagement.

Given the mentioned benefits of embedding researchers in conservation agencies, this model of knowledge exchange deserves more formal attention and investment. However, systematic research on embedding and other models of knowledge exchange (e.g. use of knowledge brokers* or boundary organisations**), across different world contexts, is required to better understand their relative values and the full range of benefits, costs, and institutional arrangements.

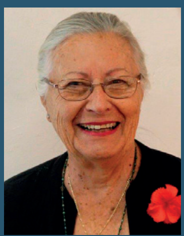
** knowledge brokers are intermediaries, often from academia, who develop relationships between producers and users of knowledge*
*** boundary organisations facilitate knowledge exchange across science-policy boundaries while remaining relatively independent*

Reference
Roux DJ, Kingsford, RT, Cook CN, Carruthers J, Dickson K & Hockings M (2019) The case for embedding researchers in Conservation agencies. Conservation Biology 33: 1266-1274.

Identifying Knysna waterbird community changes: the value of citizen science

Long-term monitoring aids understanding the dynamics of waterbird abundance, and identifying consequences of the many challenges they face. It is also essential for identifying and focusing local and international conservation efforts to help secure a long-term future for this vulnerable group of birds.

Ian Russell



Lorna Watt

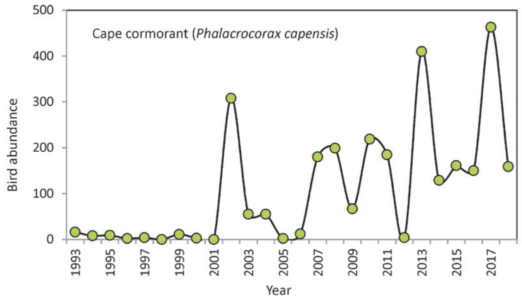
Active involvement in some monitoring programs by citizens who are not necessarily formally trained in scientific study, yet have a passion for conservation and learning, is encouraged by SANParks. Seldom, however, are there instances where such citizen scientists both take the lead in field surveys and are consistently involved in long-term monitoring running over decades, yielding high quality scientific data. One such program is the waterbird monitoring program conducted in the Knysna Estuary by the Lakes Bird Club. Waterbird surveys are undertaken mostly from boats following standardised routes, and have been regularly undertaken during both winter and summer months since 1993 by a varying group of keen, mostly amateur, birders overseen by a core group of regulars. Where necessary they have been assisted by SANParks personnel, mainly through the provision of suitable boats and skippers. The consistency with which biannual surveys have been undertaken since 1993 is remarkable given the many challenges posed particularly by variable coastal weather, with windy weather frequently making accurate surveys extremely difficult. Dedicated birders are, by necessity, attentive weather watchers, and in the case of surveys on large waterbodies like Knysna Estuary, are always waiting for that elusive rain- and wind-free weather window.

A birding citizen scientist team (Coordinated Waterbirds Count or "CWAC" team) preparing to set out on a survey on a clear Knysna morning. © Lorna Watt

Analysis of the resulting valuable data set reveals long-term changes in the abundance of several species. Cape cormorant is one species that has increased in abundance in the Garden Route area, with less than 20 individuals recorded on Knysna Estuary in summer counts during the first nine surveys (1993 to 2001), and >150, and at times in excess of 400 individuals, now regularly recorded (Fig. 1). This change in abundance conforms with the spatial shift of this species from the west to the east coast of South Africa, following a shift to the south and east in the distributions of the Cape cormorant's main prey species, particularly anchovy and sardine. Egyptian goose is another species that has undergone long-term increases in abundance in the Knysna area (Fig. 2), which is consistent with increases reported throughout the Western Cape (and nationally) over the past few decades. A changing rural landscape is the likely cause for reported increases, with Egyptian goose benefiting in many parts of its range from increasing numbers of farm dams, pastures and grain crops which supplement their food supply, and trees for breeding.

Survey results also reveal that the abundances of several waterbirds are declining. For example, the abundance of some dabbling ducks, such as the near endemic Cape shoveller, is decreasing in Knysna Estuary (Fig. 3) as well as other Garden Route lakes. The exact causes of such declines are not clear, though they are possibly associated with broader habitat changes. Similarly, the abundance of some migratory waders, such as the Curlew sandpiper, has declined dramatically over the past few decades (Fig. 4). The cause of decline in these and other palearctic migrants invariably includes habitat loss at migratory stop-over grounds between their northern hemisphere breeding and southern hemisphere non-breeding areas, as well as gradual habitat degradation across most of their extensive range throughout Asia, Europe and Africa.

Waterbirds are not confined to conservation areas, and are impacted by a range of environmental changes in their home ranges, which for many species includes areas beyond our region. It is frequently stated that loss of natural wetlands in South Africa approximates 50%, though a recent study has reported long-term global averages may be as high as 87%, with most remaining wetlands affected to some extent by human activities. This has obvious detrimental consequences for all aquatic biota that are dependent on these ecosystems, including waterbirds.



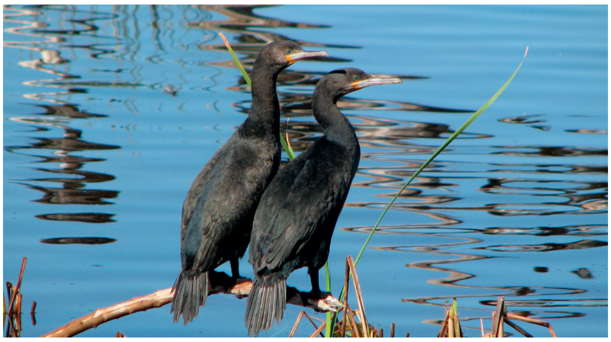


Figure 1. Abundance of Cape cormorant in Knysna Estuary during summer (January) counts showing increasing abundance from 1993-2018. Cape cormorant abundance, a southern African endemic, is declining nationally, and has an increased proportion of birds breeding on the southern coast due to changing marine conditions and resultant eastward displacement of their main prey. © Ian Russell

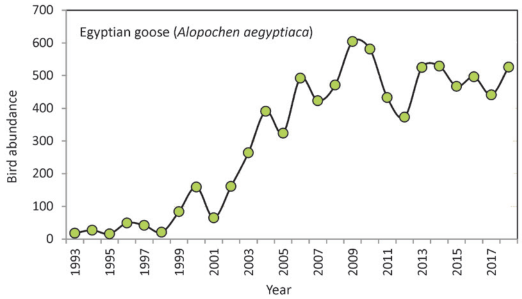


Figure 2. Abundance of Egyptian goose in Knysna Estuary during summer (January) counts showing increasing abundance from 1993-2018. Egyptian geese have benefited from agricultural development and is increasing in abundance in many places throughout South Africa. © Vincent Pienaar

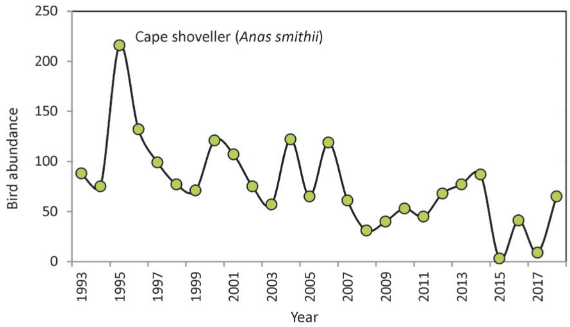


Figure 3. Abundance of Cape shoveller in Knysna Estuary during summer (January) counts showing decreasing abundance from 1993-2018. © Vincent Pienaar

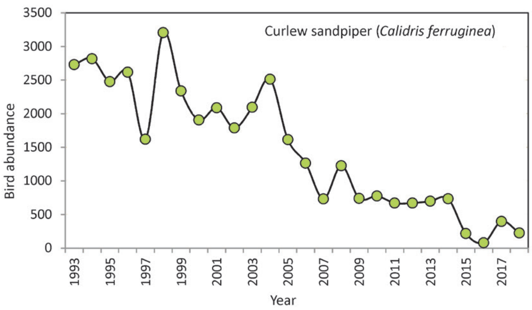


Figure 4. Abundance of Curlew sandpiper in Knysna Estuary during summer (January) counts showing decreasing abundance from 1993-2018. © Vincent Pienaar

Ants and fire interact to affect bark recovery in African savanna trees

Nest-building ants are found to inhibit bark recovery of marula trees in Kruger National Park, particularly where fires are excluded

Corli Wigley-Coetsee

Benjamin Wigley

Elephants can cause significant tree mortality through multiple mechanisms including ringbarking and pollarding (breaking of main stem). Bark damage resulting from elephant feeding is common in African savanna trees and although ringbarking can lead to the tree dying, it is often the subsequent interactions with fire, insects and other pathogens that result in tree mortality. Surprisingly, very little is known about how savanna trees respond to bark damage caused by elephants. To address this knowledge gap, we investigated how the inner bark of marula (*Sclerocarya birrea*), a widespread savanna tree species favoured by elephants, recovers after bark damage.

We used a long-term fire experiment in the southern region of the Kruger National Park to measure bark recovery with and without fire. A 50 mm diameter section (~20 cm^2) of bark was removed from five trees in three treatments (treatments were annual and biennial burns and no burns), replicated on each of the four strings of the Pretoriuskop burn plots in July 2016 using a hammer and sharpened soil corer. The bark wounds were made at a height of 0.5 m above ground level to place them within the flame zone of subsequent fires. Both fire treatments were burnt in August 2016 and the annual August burn was burnt again in August 2017. All trees were re-surveyed in June 2017, September 2017 and again in July 2018. During each survey, the length of the recovered proportions of inner bark was measured on both the vertical and horizontal planes and then converted to percentage recovered. As the study progressed, we noticed a number of ant nests in the bark wounds, and to determine if ant presence influenced bark recovery, we made a note of the presence/absence of ant nests in wounds to include as a covariate in our analyses.

Bark recovery was significantly lower in unburned plots compared to both the annual and biennial burn treatments. Twenty-four months post-damage, mean wound closure was 98, 92, and 72% respectively in annual, biennial and fire exclusion treatments (Fig. 1a). However once the presence of ant nests was accounted for, differences in recovery rates among treatments were no longer significant (Fig. 1b). In other words, the presence of ant nests in damaged areas significantly lowered bark recovery rates across all treatments, while fire had no significant effect. Overall, the proportion of trees with ant nests present was significantly higher in unburned plots (50%) compared to annual (15%) and biennial burn (25%) treatments.

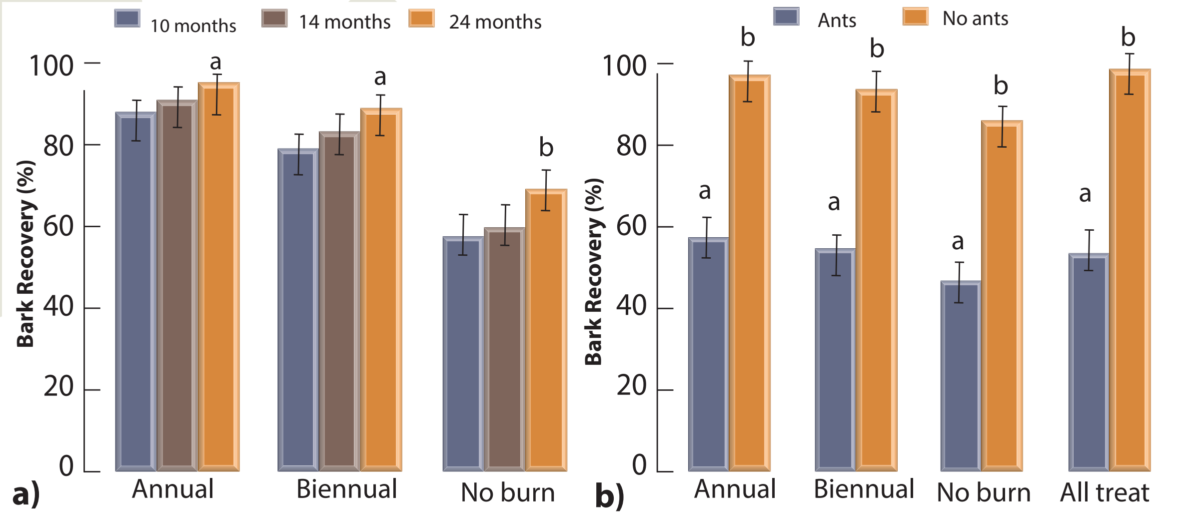


Figure 1. Mean percentage ± standard error bark recovery in a) annual, biennial and no burn treatments at 10, 14 and 24 months after damage, and b) for trees with ant nests present vs. ant nests absent in annual, biennial, no burn treatments and pooled across all treatments.

Our findings suggest that if the area where bark was damaged is not colonised by ants, bark recovery in marula trees can be rapid for smallish wounds, even if the trees are subsequently exposed to fires (see Fig. 1a and 2a). However, the colonization of bark wounds by ants – which we found to be negatively related to fire frequency – significantly impaired bark recovery (Fig. 1b). Previous work on ants at the same long-term fire experiment found significant differences in the composition of ant assemblages between burn and no burn treatments, as has been shown elsewhere (but little change in ant abundance). Our results suggest that fire exclusion can benefit arboreal nesting ants such as *Crematogaster castanea* (Fig 2b); the main nest-building ant species in the removed bark cores on the experimental burn plots. *Crematogaster* spp. are often forest-associated species and have also been shown to increase with fire exclusion in Australian savannas.

Reference
Wigley BJ, Coetsee C, Kruger LM, Ratnam J & Sankaran M (2019) Ants, fire and bark traits affect how African savanna trees recover following damage. Biotropica 51: 682-69

Thus in true accordance with the old saying "the devil is in the detail", this study which simply set out to determine the effect of fire on bark recovery resulted in the unexpected finding that ants appear to hinder bark recovery and that fire removal resulted in higher rates of colonisation by ant species that hinder bark recovery by nesting in bark wounds or at the edges of bark wounds. It prompts one to think of the other myriad interactions in savannas that may be important to tree recruitment and persistence of which we are still unaware.

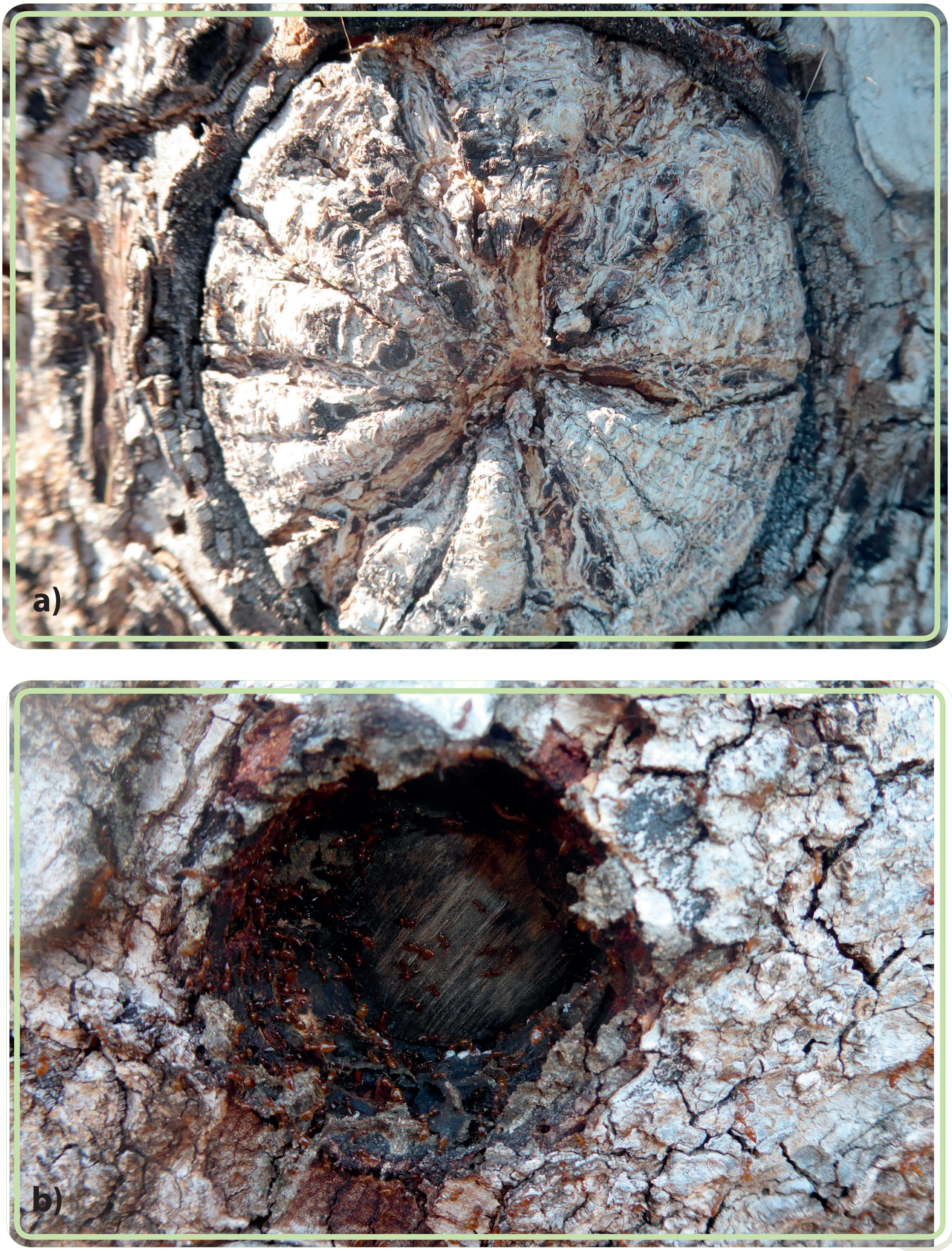


Figure 2. a) A fully recovered bark wound on a marula tree that was not colonised by ants in the annual burn treatment after 24 months, and b) a unrecovered bark wound from a tree that was colonised by *Crematogaster castanea* in the no burn treatment after 24 months. © Benjamin Wigley

Herbivore management influences fire patterns in Kruger National Park

Grazing animals and fire compete for grass - when Kruger National Park stopped large-scale culling, it changed the fire patterns in the park by reducing fire, especially in areas close to rivers

Izak Smit

Grazing animals and fire are in direct competition – both of them consume grass. Previous continental scale studies suggest that grazing animals remove the bulk of grass biomass in drier and more nutritious landscapes, whilst fires dominate in wetter and nutrient poor landscapes. Areas with intermediate rainfall (500 - 800 mm per annum) are particularly interesting, because it seems as if either grazers or fire can gain the competitive edge. One of the best examples is the Serengeti where about 70 - 80% of the area used to burn annually after the blue wildebeest population was decimated by rinderpest, but since the wildebeest numbers recovered, annual fire extent has dropped to about 40%. A central question for conservation managers is whether management actions can switch a system from fire- to herbivore-driven?

The Kruger National Park (KNP) used to cull large herbivores (hippo, buffalo and elephants) to keep their numbers within predetermined intervals. However, culling was discontinued during the mid-1990s and as a consequence the biomass of these animals has more than doubled. Using long-term data on fire patterns in the park, as well as census data of these large herbivore species between 1969 and 2015, it was possible to answer whether KNP has switched from a fire- to a herbivore-driven system.

Figure 1. Grazers "switching off" fires; grazers keep grass too short to burn in a heavily-grazed area (a) next to a river or (b) around termite mounds. © Izak Smit

We found that as herbivore biomass increased after culling was discontinued, fires decreased, especially close to rivers (Fig. 2). This is most likely due to the direct competitive effects of herbivores consuming the grass, leaving less grass biomass and shorter grass, and hence reducing fire occurrence (see Fig. 1). We expect that fire intensity would also have decreased with increased herbivores removing grass biomass.

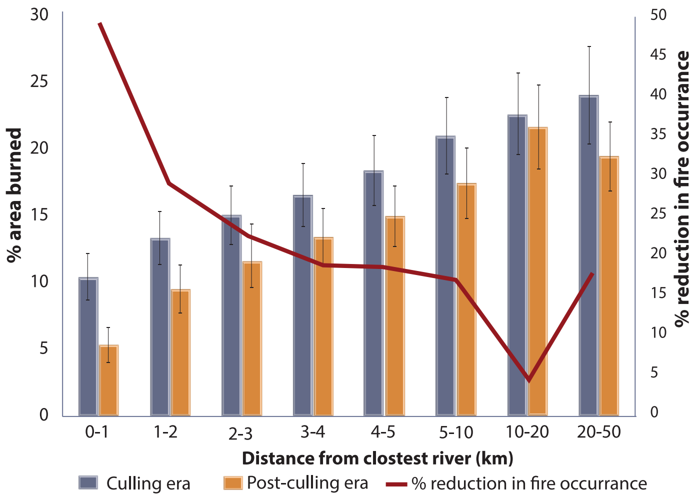


Figure 2. Fire occurrence has reduced, especially close to rivers, since culling ceased.

However, the effect of an increasing grazer population was not similar everywhere. Grazers reduced fires more in areas close to rivers as opposed to areas further from rivers (Figs. 2-3). This is likely because hippo, buffalo and elephant are water dependent grazers and spend considerable time foraging close to rivers. We also discovered that grazers had a stronger effect in drier than in wetter landscapes of KNP (compare Figs. 3a and 3b). The most likely reason for this is that drier landscapes are less productive and hence grazers can have a large effect on grass biomass (and hence outcompete fire), whereas in more productive higher rainfall landscapes, grazers cannot "keep up" with the grass growth, leaving more grass for fires to consume. As such, the results suggest that gradients in grazing intensity, e.g. distance to water, can result in both herbivores and fires dominating in different areas within the same open system. For example, on average less than 1% of arid landscapes within 5 km from rivers burnt annually in the presence of high herbivore biomass (predominantly herbivore-driven system), as opposed to 25% annual area burnt in higher rainfall landscapes further than 5 km from rivers (predominantly fire-driven system), all within the same protected area.

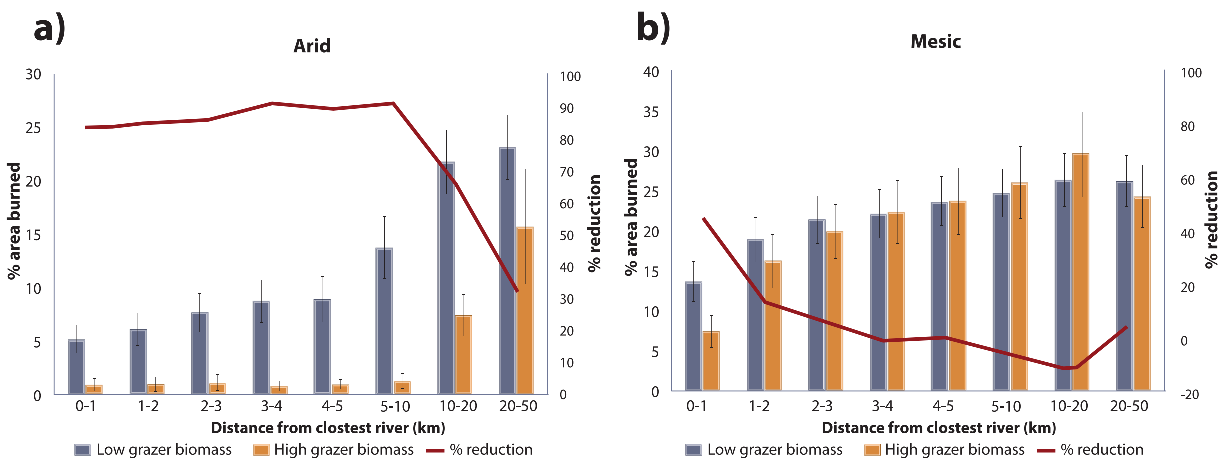


Figure 3. Years with high grazer biomass burn less than the same areas during years with lower grazer biomass. Furthermore, arid landscapes (a) and areas closer to rivers burn less than higher rainfall landscapes (b) and areas further from rivers.

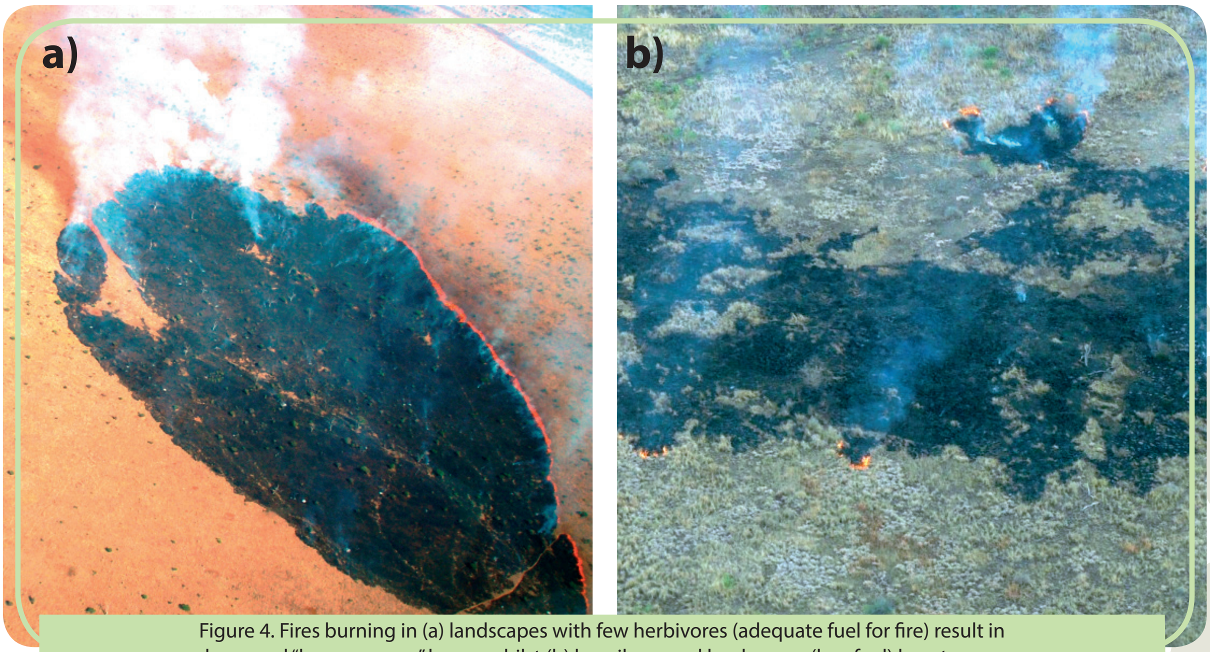


Figure 4. Fires burning in (a) landscapes with few herbivores (adequate fuel for fire) result in large and "homogenous" burns, whilst (b) heavily grazed landscapes (less fuel) burnt more patchy and often result in smaller more heterogeneous fires. © Sally Archibald

Our results reiterate how important it is to take a "systems" view in conservation, with many processes interconnected – when you manage one process (e.g. herbivores), you may also affect another process (e.g. fires). In conclusion, within the intermediate rainfall range for savannas (500-800 mm per annum), management can influence the competitive effects between herbivores and fires. Furthermore, we propose that grazing gradients – in this case distance to closest perennial river – are critical as it allows both fire- and herbivore-dominated systems to occur within the same system, increasing heterogeneity with positive implications for biodiversity. This increases management possibilities, as management actions that induce grazing gradients can have positive implications for maintaining biodiversity in protected areas.

Reference
Smit IPJ & Archibald S (2019) Herbivore culling influences spatio-temporal patterns of fire in a semi-arid savanna. Journal of Applied Ecology, 56: 711-721

How does frequent burning affect Kruger's soils?

African savannas are shaped by and are dependent on fires to maintain ecosystem health, not just from a vegetation perspective, also due to resilient soils that are able to cope with regular fires

Tercia Strydom

Fire-related research often focuses on the effect of fires on vegetation and animals, but there is very little understanding of the impact of fires on soils. Soils are fundamentally important for cycling nutrients, filtering water and providing a medium in which plants can grow. Studies from other ecosystems around the world found that fires, particularly intense wildfires, can impact soil hydrology and nutrients, and ultimately affect ecosystem productivity. However, there is lack of studies confirming the impact of fires on soil hydrological properties in African savannas. This research gap is quite interesting considering that the Soil Conservation Act 45 of 1946 had strict regulations regarding the use of veld burning practises across South Africa due to the concern that fire increases soil erosion and land degradation. Fires play an important role in maintaining ecosystem functioning (mostly by maintaining above-ground vegetation ratios) in the Kruger National Park (KNP). Our research aimed to investigate the impact of varying fire frequencies below-ground by considering the impact on soil water dynamics and nutrients. The Experimental Burn Plots are part of a long-term fire experiment that was initiated in KNP in 1954, which provides the ideal opportunity to carry out this study.

In order to determine the effect of fire frequency on soil hydrology and nutrients, we compared soil infiltration rates (K_{unsat}) (Fig. 1a), saturated hydraulic conductivity (K_{sat}) (Fig. 1b), water holding capacity and total carbon and nitrogen concentrations across soils that were burnt every year in August (annual burn), every 2-4 years (variable fire) and unburnt (no burn). This was repeated across the two dominant geologies in KNP; i.e. granites, characterized by typical coarse-grained, sandy soils and basalts, characterized by fine-grained, clayey soils. Although our initial hypothesis was that frequent burning would decrease soil infiltration rates, our results did not support this (Fig. 2a). Instead, we found that it was time since the last fire that had a greater effect on infiltration (i.e. soils more recently burned had lower infiltration rates, data not shown). We believe that the effects on infiltration rates will dissipate and return to rates similar to that of unburnt soils within a relatively short period of time.

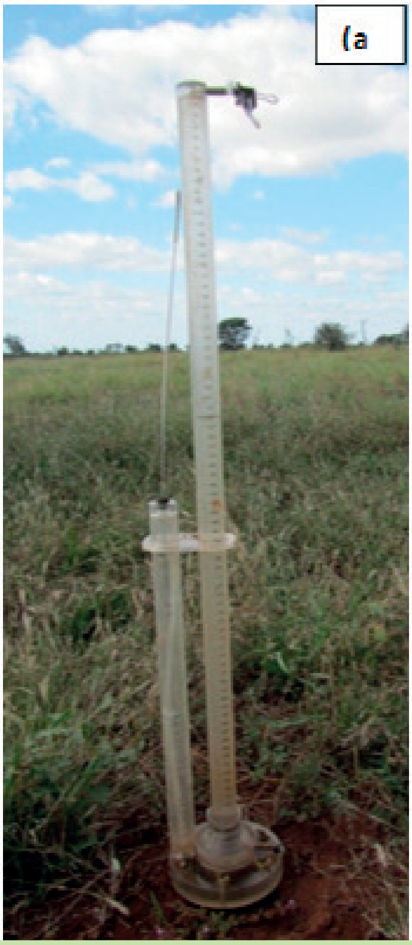


Figure 1. (a) Tension Disc Infiltrometer to measure soil infiltration rates (K_{unsat}) and (b) Guelph Permeameter to measure saturated hydraulic conductivity (K_{sat}). © Tercia strydom

Fires did not affect soil hydrological properties below the soil surface and saturated hydraulic conductivity was unaffected by increased fire frequencies (Fig. 2b). This may be due to fire behaviour and how fast it spreads over the soil surface. Fires in KNP can burn as fast as 30 m/min compared to 2-4 m/min in some European ecosystems. Lack of burning on the basaltic soils, where fires had been excluded for >60 years, led to increased concentrations of total carbon and nitrogen (data not shown). This, along with the finding that fire exclusion increases the water holding capacity of soils, particularly on the basalts, may be attributed to soil texture. Increased clay content is positively correlated with increased carbon and nitrogen. These hydrophilic nutrients in conjunction with higher ratios of clays, plays a major role in the ability of a soil to retain moisture. This is critical in a post-fire environment to facilitate quick recovery of vegetation.

Fires in KNP do not lead to long-term negative effects on soil infiltration rates and saturated hydraulic conductivity. There is no major difference in water holding capacity, carbon and nitrogen between annually burnt soils and soils burnt every 2 – 4 years. Unsurprisingly, these properties are greatest in unburnt soils which we suspect has to do with many decades of vegetation growth and high levels of hydrophilic soil organic matter. Our findings suggest that fires are important in maintaining both spatial and temporal variation in carbon and nitrogen concentrations, which has a positive cascading effect on soil hydrology and post-fire soil water holding capacity. Furthermore, the fact that frequent burning does not lead to long-term negative effects on soil hydrology, emphasizes how resilient these savanna systems are to fires. Our study provides valuable insight into fire, soil and water interactions in these landscapes where there is a limited body of knowledge.

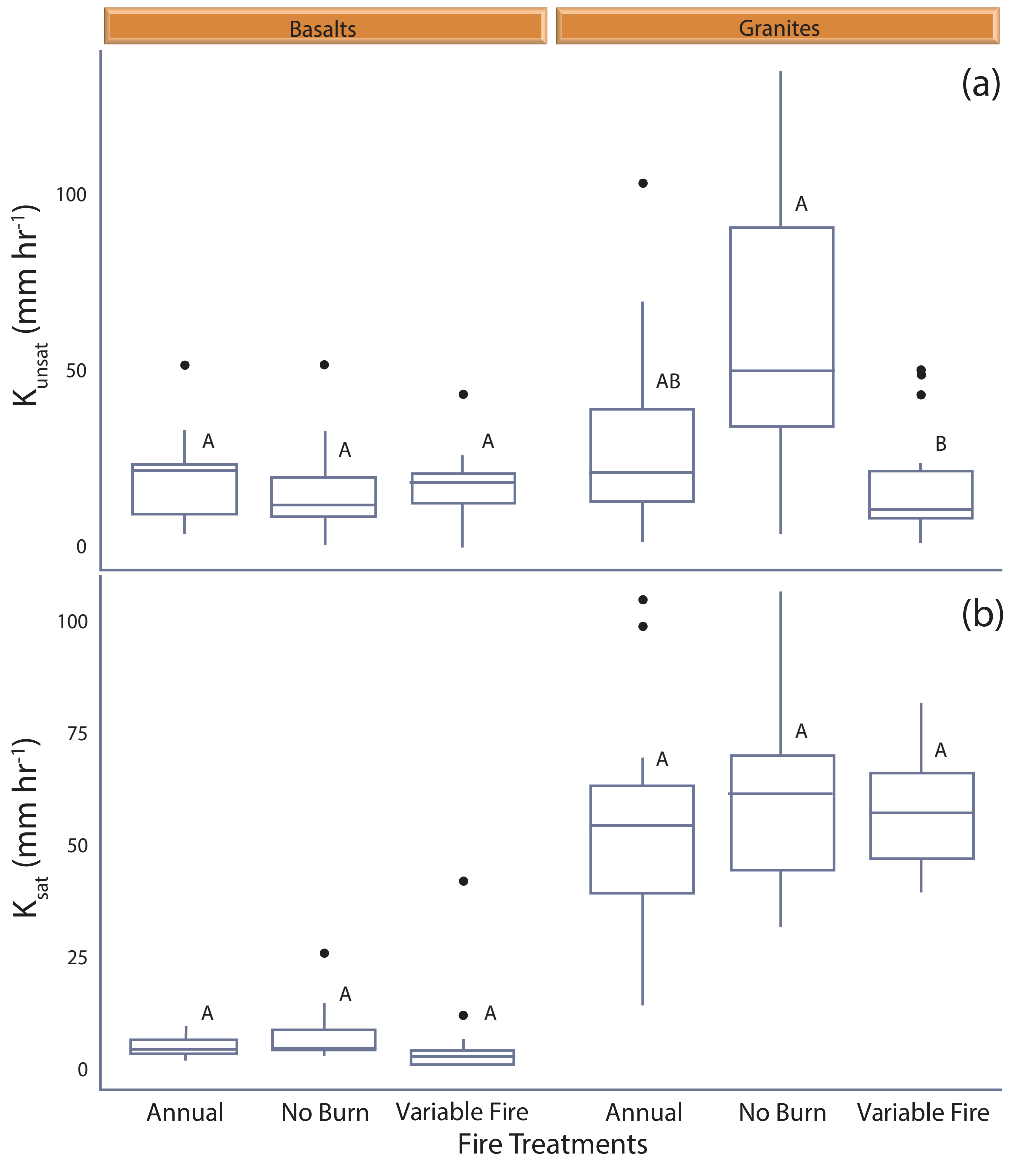


Figure 2. The effect of varying fire treatments on (a) soil infiltration rates and (b) saturated hydraulic conductivity across basalt- and granite- derived soils. Different uppercase letters denote significant differences at $p < 0.01$.

Reference
Strydom T, Riddell ES, Rowe T, Govender N, Lorentz SA, le Roux P.L, Wigley-Coetsee C (2019) The effect of experimental fires on soil hydrology and nutrients in an African savanna. Geoderma 345: 114–122.

Factors contributing to the June 2017 Knysna Fire: An assessment of climate, weather and fuel factors

The extent, severity and impact of large, damaging wildfires such as the Knysna fires are influenced by a number of factors, including the occurrence of extreme weather conditions (sometimes attributed to global climate change), a build-up of fuel often resulting from extended periods of fire suppression, increased sources of ignition that are linked to growing human populations, expansion of the urban-wildland interface, and invasion by flammable alien plants.

Johan Baard

Large damaging wildfires are a significant and growing problem in many parts of the world. In fire-prone regions such as California, Australia, Spain, Portugal and Greece fires have resulted in the death of many people in recent times, killed livestock and wildlife, and destroyed thousands of buildings, frequently in a single fire event. Wildfires also occur in South Africa's fynbos shrublands, but they have generally tended to be less severe in terms of damage and loss of life. However, in June 2017, wildfires burned 15 000 ha around the town of Knysna in the Western Cape, destroying over 800 buildings, more than 5 000 ha of plantations, and claiming the lives of seven people, making this one of the worst fires on record in the region.

We obtained daily weather data from the town of George (20 km west of the area burnt in the 2017 Knysna Fires) for the period 1943 – 2017, and from Knysna for the period 1997 – 2017. We calculated daily fire danger indices (FDIs) from temperature, relative humidity, rainfall and wind speed, and compared the fire weather conditions during the 2017 Knysna Fires to the long-term weather record. Daily weather conditions associated with the 2017 Knysna Fires were most severe on the 6th of June, the day before the fire started. High temperatures and low relative humidity prevailed, followed by high wind speeds the next day. FDI on the 6th of June was categorised as 'very high'. Equivalent, or worse fire danger

	Temp	Humidity	Wind	FDI	DF	KBDI
Knysna on 6 June 2017	0.76	0.08	59.08	0.05	0.91	0.53
Knysna on 7 June 2017	70.63	6.05	0.08	0.94	0.91	0.49

Interpretation of the graph:

The graph shows the conditions at the time of the fire, as a percentage of how often it occurred in the past (from the historic records).

1 Temperature: Only 0.76 % of days were hotter than on the day the fire started.

2 Humidity: 99.92% of days in past records had higher humidity (low humidity increase fire risk).

3 Wind speed: Only one out of 1250 days had higher wind speed than the 2nd day of the fire.

4 5 6 Fire danger indices on the days of the fires were in the top 0.1 – 0.2% of days in the historic record, indicating that the fire weather conditions were extreme but not unprecedented.

FDI = McArthur forest fire danger index
DF = drought factor
KBDI = Keetch Byram drought index

Figure 1. Percentage of days that the conditions that the Knysna fires took place on (temperature, humidity and wind) occurred in the historic records of the area.

conditions occurred on approximately 0.1% of days at George (since 1943), and on 0.05% of days in Knysna since 1997; the fire weather conditions were extreme but not unprecedented (Fig.1). The fire was preceded by a prolonged drought; the eighteen-month running means for two drought indices, the drought factor and Keetch Byram drought index, were the highest on record. It appears that the severity of the fire was exacerbated by very severe fire weather, preceded by an unprecedented drought, and further worsened by the conversion of natural fynbos vegetation to plantations, and associated invasion of vegetation by alien trees.

© Stef Freitag-Ronaldson

We used satellite imagery to assess fire intensity and completeness of burn in different land cover types. Fire intensity differed significantly among land cover categories. Biomass consumed was 13% higher in natural vegetation invaded by aliens and 8% higher in plantations than in natural fynbos. Fire intensity was significantly higher in plantations of alien trees and in fynbos invaded by alien trees than in uninvaded fynbos, providing support for the contention that invasion by alien trees increases the impact and difficulty of control of wildfires.

© Stef Freitag-Ronaldson

Historic fire suppression resulted in fuel build-ups in natural vegetation, further aggravating the problem of fire control. For example, protection of fynbos vegetation from fire for 37 years resulted in an increase in fuel loads (quantity of above-ground biomass that will burn) from 2 tonnes/ha in regularly burned vegetation to 7 tonnes/ha. Residential development within and adjacent to fire-prone areas further increases the risks faced by residents.

Fire events like these are infrequent and people can quickly lose interest in implementing fire-wise practices, becoming increasingly willing to place developments in high-risk areas during the long inter-fire periods. Our results support calls for the re-introduction of programs of prescribed burning in addition to fire suppression, effective programs to control the spread of invasive alien plants, stricter regulation of residential and other development along the urban-wildland interface, and a re-examination of the costs and benefits of plantation forestry in fire-prone areas.

Reference
Kraaij T, Baard JA, Arndt J, Vhengani L & van Wilgen BW (2018) An assessment of climate, weather and fuel factors influencing a large, destructive wildfire in the Knysna region, South Africa. Fire Ecology 14 (4): https://doi.org/10.1186/s42408-018-0001-0

The characteristics and composition of the soil seedbank and its role in ecosystem dynamics and potential for rehabilitation in Tankwa Karoo National Park

Seeds collected from soil seedbanks in all vegetation types in the Tankwa Karoo National Park are abundant, but much less diverse than aboveground vegetation, suggesting active restoration may be required for perennial species

Mmoto Masubelele

Manaam Saaed

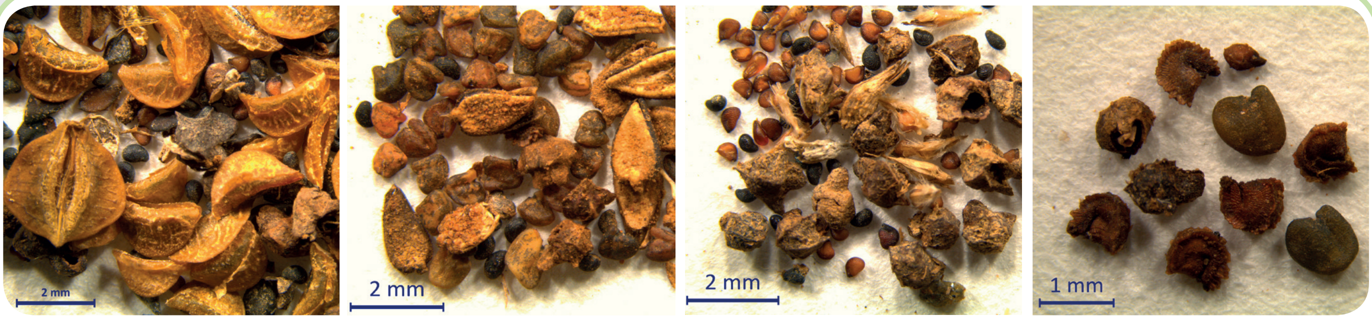
The soil seed bank is important for an ecosystem's resilience and represents regeneration potential for many plants. Arid adapted plant species survive harsh conditions by accumulating a large seed bank that stays viable over the longer term. Few soil seedbank studies have been conducted in South Africa, especially in arid rangelands. Insights into the soil seedbank could therefore improve assessment of rangeland dynamics and enhance rehabilitation efforts. However, the potential contribution of soil seed banks to effective restoration still remains unclear, as some but not many valuable species build up a persistent seed bank. This study aimed to characterise the soil seedbanks in various vegetation types of the arid Tankwa Karoo National Park.

Soil was sampled at 43 sites at the end of spring and the end of autumn, and the composition and structure of aboveground vegetation was described at the peak growth period in spring. The aboveground vegetation was measured in the field using a line-point survey method. Seeds were obtained from the soil samples by flotation in a salt solution. These seeds were then planted to determine the species composition after germination. Soil seed bank vegetation and the individual number of seedlings that germinated were recorded as they emerged.

Most seeds collected were small, i.e. less than 3 mm. Overall seed density was 8 034 seeds/m^2 of which just over half was viable (Table 1). The common life-forms were therophytes (desert annuals) and chamaephytes (low growing perennial shrubs). Species richness and diversity were lower in the seedbank compared to the aboveground vegetation, and the two vegetation spheres (above vs below) were 25% similar (Fig. 1, Motyka's similarity index), with a significant difference among the various vegetation types ($p = 0.005$). Similarity was highest in the Tanqua Wash Riviere vegetation type at 31%, and lowest for the Tanqua Escarpment Shrubland at 14%, while it was 28% for Tanqua Karoo vegetation.

Table 1. Mean values (± standard error) for the various soil seedbank variables with altitude and slope across the various vegetation types within Tankwa Karoo National Park: Tanqua Karoo (TK), Tanqua Wash Riviere (TWR), and Tanqua Escarpment Shrubland (TES), with the significant difference (p-value) among the examined vegetation types.

Variable	TK	TWR	TES	p-value
Seed density seed.m^{-2}	11095 (± 1620)	6068 (± 940)	6768 (± 1203)	0.002
Seed viability %	67.9 (± 2.89)	55.9 (± 3.98)	38.4 (± 3.66)	< 0.001
Seed species richness	6.77 (± 0.66)	6.03 (± 0.58)	7.27 (± 1.17)	0.822
Seed Shannon-Wiener index	1.38 (± 0.09)	1.37 (± 0.09)	1.36 (± 0.18)	0.827
Seed species evenness	0.79 (± 0.03)	0.83 (± 0.03)	0.66 (± 0.07)	0.488
Low growing perennial shrubs %	41.0 (± 4.62)	46.2 (± 4.74)	37.2 (± 4.54)	0.031
Annual desert plants %	59.0 (± 4.78)	53.6 (± 4.73)	54.4 (± 5.20)	0.126
Underground plants %	0.00 (± 0.00)	0.00 (± 0.00)	8.23 (± 2.41)	< 0.001



Seeds extracted from Tankwa Karoo soils show lots of morphological diversity

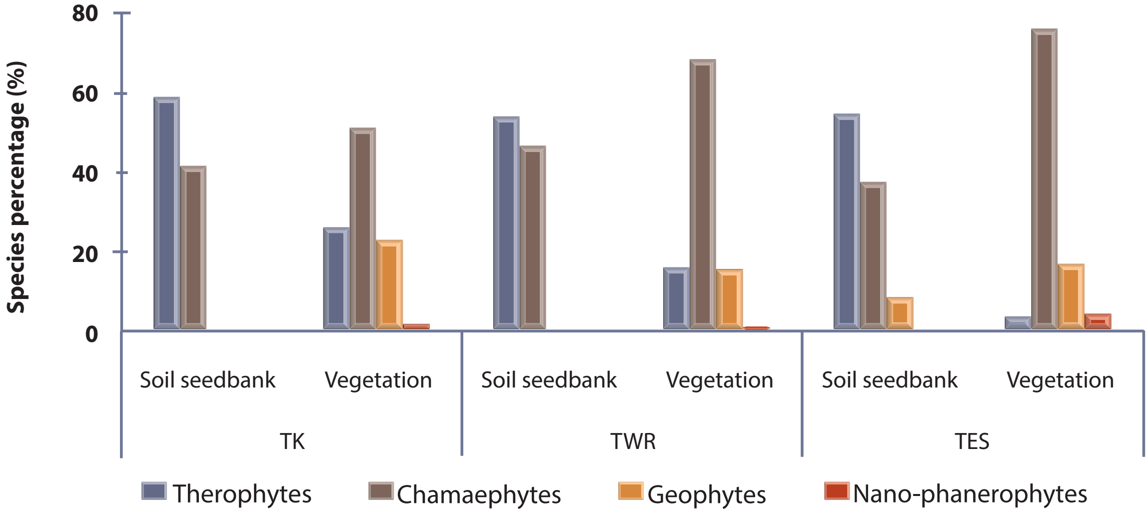


Figure 1. The percentage representation of the various life-forms within the soil seedbank and the vegetation for the examined vegetation types: Tanqua Karoo (TK), Tanqua Wash Riviere (TWR), and Tanqua Escarpment Shrubland (TES) (Reproduced from Saaed et al. 2018)

Results suggest that there were enough viable seeds for future regeneration and rehabilitation initiatives for annual species. However, restoration may be impeded by the absence of perennial species in the soil seedbank if these do not recruit vegetatively. Future work should investigate how succession progresses from annual- to perennial-dominated vegetation and whether the re-establishment of perennials will depend on management interventions.

Examples of different types of vegetation found in Tankwa Karoo National Park; Tanqua Escarpment Shrubland (top), Tanqua Karoo vegetation type (left) and Tanqua Wash Riviere vegetation type (right). © Mmoto Masubelele

Reference
Saaed MWB, Jacobs SM, Masubelele ML, Samuels I, Khomo L & El-Barasi YM (2018) The composition of the soil seedbank and its role in ecosystem dynamics and rehabilitation potential in the arid Tankwa Karoo Region, South Africa. African Journal of Range and Forage Science 35: 351–361.

Which aliens may invade us next?

Early detection forms a key component of invasive plant management with rapid eradication of single plants or small invasions being among the best investments that can be made

Johan Baard

Invasive alien plants are considered to be a major threat to biodiversity and ecosystem services. Emerging alien species, also called sleeper weeds, are species previously thought to be benign but that may turn invasive, species that have naturalised but not yet expanded their populations exponentially, or species currently only present in a small area but having the potential to spread widely. Early detection forms a key component of invasive plant management with rapid eradication of single plants or small invasions being among the best investments that can be made. Knowledge of the incidence of alien plants and monitoring of changes in their status underpin sound management interventions and are mandated by the National Environmental Management: Biodiversity Act (NEMBA, Act 10 of 2004) in South African protected areas.

Fragmentation and accessibility associated with a well-developed road network within and outside of the Garden Route National Park (GRNP) makes the park particularly susceptible to the introduction and spread of alien plant species. Although roadside surveys are limited in that only plants in the immediate surrounds can be detected, and are biased towards larger, conspicuous growth forms, they enable relatively rapid collection of substantial quantities of data.

Five hundred and thirty kilometres of roads were surveyed for the presence of alien plants in and around the GRNP between Wilderness in the west and Witelsbos in the east (Fig. 1). The focus taxa were alien and extralimital trees, shrubs, conspicuous creepers, ferns and succulents. Inconspicuous herbs and grasses as well as the most common transformer species were not considered. We then compared our records of alien plant locations per quarter degree square (QDS) with those of the South African Plant Invader Atlas (SAPIA) and invasive species listed by NEMBA to identify species that to date have been absent from SAPIA and NEMBA, but that are showing signs of spread in the Garden Route.

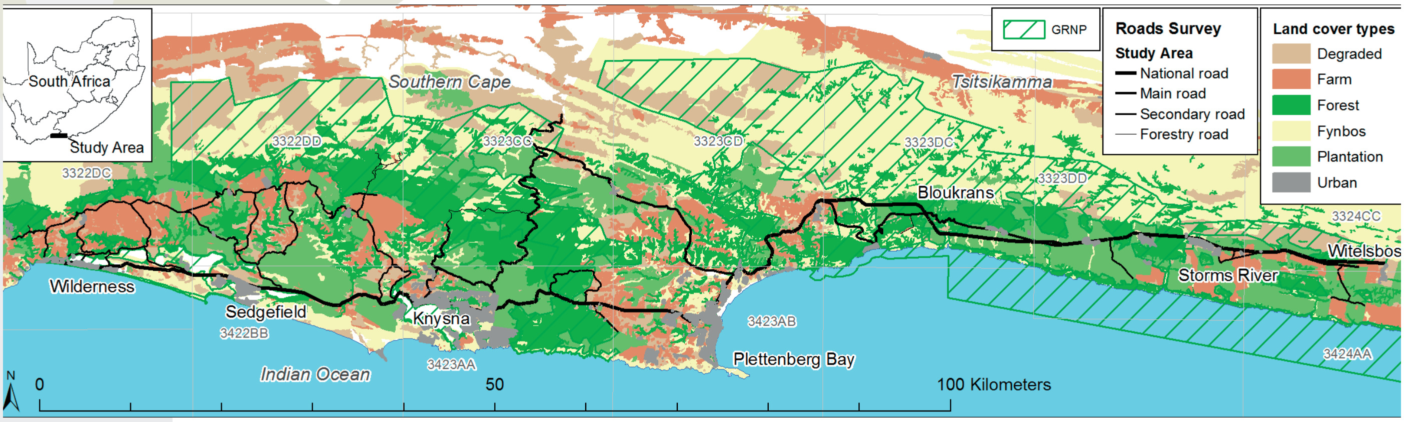


Figure 1. The study area showing the Garden Route National Park, the Southern Cape and Tsitsikamma regions, the roads surveyed and the land cover types adjacent to roads.

In this rapid assessment, 109 exotic plant species were recorded across 1942 locations. Thirty-five of these species were not NEMBA-listed and 35 species have not been recorded by SAPIA for the study area. The most abundant species by numbers were *Nephrolepis cordifolia* (sword fern), *Ammi visnaga* (false Queen Anne's lace, toothpick weed) and *Lantana camara* (lantana). The species that occurred at the most locations (indicative of wide distributions) were *Acacia* elata (pepper tree wattle) and *Cortaderia selloana* or *C. jubata* (pampas grass). Some species were exclusive to the Southern Cape (roughly George to Plettenberg Bay) and others to the Tsitsikamma (roughly Plettenberg Bay to Kareedouw turn-off) and others to the Tsitsikamma. The most noticeable additions to SAPIA records for the region were the herb Ammi visnaga and *Sphaeropteris cooperi* (Australian tree fern). Other additions included *Alnus sp., Solanum chrysotrichum, Banksia ericifolia* (heath-leaved banksia) and *Cupressus arizonica* (Arizona cypress). Ten extralimital species were recorded; the most abundant was *Tecoma capensis* (Cape honeysuckle).

Giant Devil's Fig (*Solanum chrysotrichum*) is a new arrival in the Garden Route National Park and only found in the Tsitsikamma area at present but it has the potential to invade over large areas. © Johan Baard

Australian Tree Fern *(Sphaeropteris cooperi)* spreads by spores and poses a large threat to biodiversity as it has the potential to invade many habitats under different light regimes. © Johan Baard

Roads associated with natural vegetation had fewer species and densities of alien plants than those associated with degraded or transformed land. Roads along farmland had the highest incidence of alien plants and species. Plantations have lesser infestations than other degraded land. Several sleeper weeds are widely distributed along roads in the study area. *Ammi visnaga* occurred most abundantly. *Sphaeropteris cooperi* is not listed by NEMBA. Unless overlooked in previous surveys, *S. cooperi and A. visnaga* have spread most markedly compared to SAPIA records. Quercus robur is not NEMBA-listed and has been considered a casual alien in the GRNP. However, 31 instances of dispersal exceeding 100 m from, and in addition to reproduction in the immediate surrounds of, parent trees indicate the species to be invasive.

More than a 100 new exotic species were added to the alien plant list during a rapid assessment in the Garden Route National Park. The most abundant of these were sword fern, false Queen Anne's lace (*Ammi visnaga*) and lantana. The three species with the widest distributions were pepper tree wattle and two species of pampas grass

Our findings confirmed the invasive status of bird-dispersed species such as *Melia azedarach* (seringa) and wind dispersed species such as *Grevillea robusta* (silky oak) and *C. selloana or C. jubata*. A few invasive species that currently do not occur inside the GRNP or occur in low numbers, have large numbers of young outside the park (e.g. *Acer negundo* (ash-leaved maple), *A. elata, Paraserianthes lophantha* (stink bean) and *M. azedarach*). These species pose a threat of invasion into the park and should be prioritised for control.

Baard JA & Kraaij T (2019) Use of a rapid roadside survey to detect potentially invasive plant species along the Garden Route, South Africa. Koedoe 61: a1515. https://doi.org/10.4102/koedoe.v61i1.1515.

Clearing efficiency is a fundamental driver of alien Acacia persistence

Ineffective treatment of alien Acacia species is costly, with >50% of future management costs predicted to result from seedbank replenishment by plants not treated due to inappropriate management planning and implementation

Nicola van Wilgen

Chad Cheney

Llewellyn Foxcroft

Australian *Acacia* species are a persistent threat to fynbos biodiversity and result in high long-term management costs. The invasion success of *Acacia* species has been attributed to their early maturity (<2 years), prolific seed production (up to 12000 seeds.m^{-2}.annum^{-1}), long-lived seed banks and abundant germination following fire. Currently, clearing operations seek to reduce invasions to a 'maintenance level' of control in national parks, where plants are 'rare' in the landscape and occur at a density of less than one plant per hectare. This is considered a realistic goal and will ensure significant reduction in ecological impact, but information on how to achieve this is lacking. Therefore, progress towards achieving this goal has been slow, and the root cause underlying management inefficiency is unclear. We made use of 20 years of data from Table Mountain National Park (TMNP), covering 22,671 hectares, to model potential future long-term (50 year) outcomes of clearing *Acacia* species at different levels of management clearing efficacy (i.e. timeliness of clearing, correct treatment, killing all plants present in an area).

As a model starting point, population data on *Acacia* species were collected across the park at a fine scale (>10 000 plots sampled). The simulation model comprised six time-based modules relating to management, population dynamics (e.g. seed germination) and ecological processes (e.g. fire) relevant to *Acacia* species. The influence of fire was modelled based on veld age and determinants such as fire ignition frequency, fire intensity and area burned, based on historical fire history data. The model was run for the equivalent of 50 simulation years at each of 38 incremental levels of clearing efficacy (5%-100%).

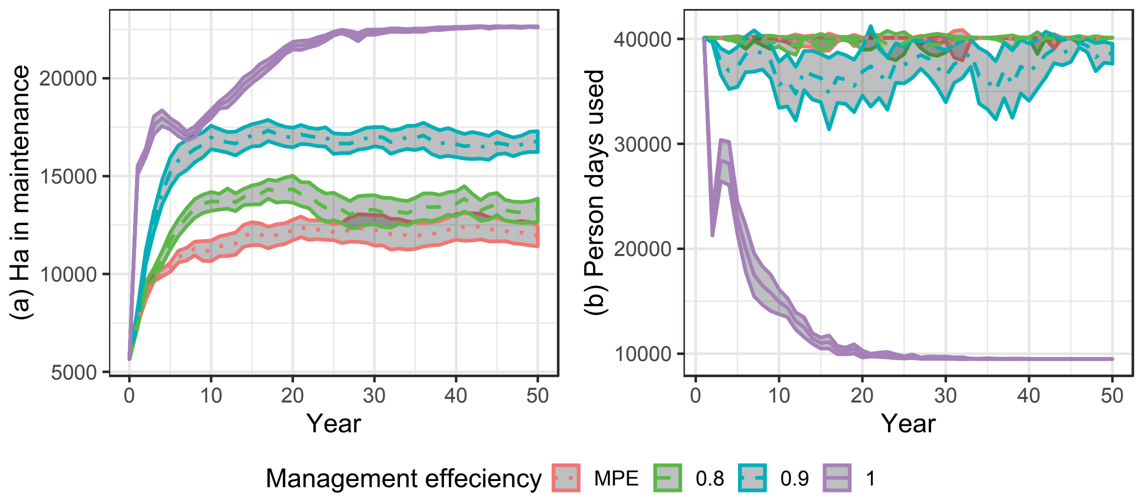


Figure 1. The impact of clearing efficacy on the area that (a) reaches the management goal of having Acacias occur at <1 plant per ha, as well as (b) the associated clearing effort required (measured in terms of person days). More efficient clearing reduces addition of seeds to the seedbank and in so doing reduces the total time and effort required for clearing in the long-term. MPE = mean project efficacy as currently measured.

Using resources currently available for management, it would take between 32 and 42 years to attain the management goal if clearing was 100% effective (Fig. 1a). The modelling revealed that (1) germination of seeds that originate from standing plants (those not cleared) made a much larger contribution to future clearing requirements than fire stimulated seed germination or germination from the seedbank that was present before management intervention, and (2) the relationship between the clearing effectiveness and the area cleared was non-linear. In other words, effectiveness relating to un-cleared adult trees is highly important. Reducing clearing efficacy to 80%, which is the current minimum standard set by Working for Water, meant that the management goal was not achieved in all areas, although the area that reached a density of <1 plant per hectare improved from 25% at present to 53% of the park in a maintenance state following 50 simulated years of implementation (Fig. 1a). Due to the non-linear relationship, even a small reduction or increase in clearing efficacy between 80-100% had large effects on the area attaining the goal. At 90% clearing efficacy three quarters of the area would be in a maintenance state after 50 years, compared to 99% of the area when efficacy is at a maximum.

The model showed that even at 100% efficacy, fire events would stimulate seedbanks in areas that would require continued follow-up work. Importantly, these results show that poor clearing efficacy is not something that can be directly rectified with increased budgets. Plants that are not cleared correctly need time to re-grow before repeat treatment can have any value. Therefore, where funding is available for initial clearing, it is not a budget problem, but a problem of clearing quality that necessitates repeat spending.

While areas of low density invasion may be considered lower priority, not reducing propagule pressure in these low density areas significantly contributes to sustained high budget requirements in the long-term (Fig. 1b). As much as 55% of future management costs would be required to treat plants that germinate as a result of seedbank replenishment from plants missed or inadequately treated. Minimizing spread into uninvaded and low density sites, as well as focussed clearing of isolated populations are a key future management concern. Though the long-term management requirements may seem disheartening, managers should be encouraged by the fact that even small increases in efficacy above 80% result in exponentially significant long-term improvements. This work shows that there is a marked distinction between simply increasing financial resources and increasing efficacy. Improving efficacy allows for decreased budget requirements over time, freeing up funding for early detection and rapid control of newly introduced species.

This paper formed part of Chad Cheney's PhD, which was awarded by Stellenbosch University for his dissertation entitled "An evidence base for improving management effectiveness of alien plants in protected areas: relationships of scale, efficiency and strategy". Chad is a park planner for Table Mountain National Park. Llewellyn Foxcroft was one of Chad's co-supervisors.

Cheney C, Esler KJ, Foxcroft LC & van Wilgen NJ (2019) Scenarios for the management of invasive Acacia species in a protected area: Implications of clearing efficacy. Journal of Environmental Management 238: 274–282

Resprouting *Acacia saligna* after ineffective treatment suggests that a change in clearing compliance measures may be required. While all plants in this plot were treated (the basic requirement), incomplete, incorrect or ineffective treatment of these plants means that they will all be producing seeds again within the next two years. © Nicola van Wilgen

Only one wild elephant left in Knysna

The use of camera trap technology has provided strong evidence for the existence of only a single female elephant in the Knysna forests.


Lizette Moolman

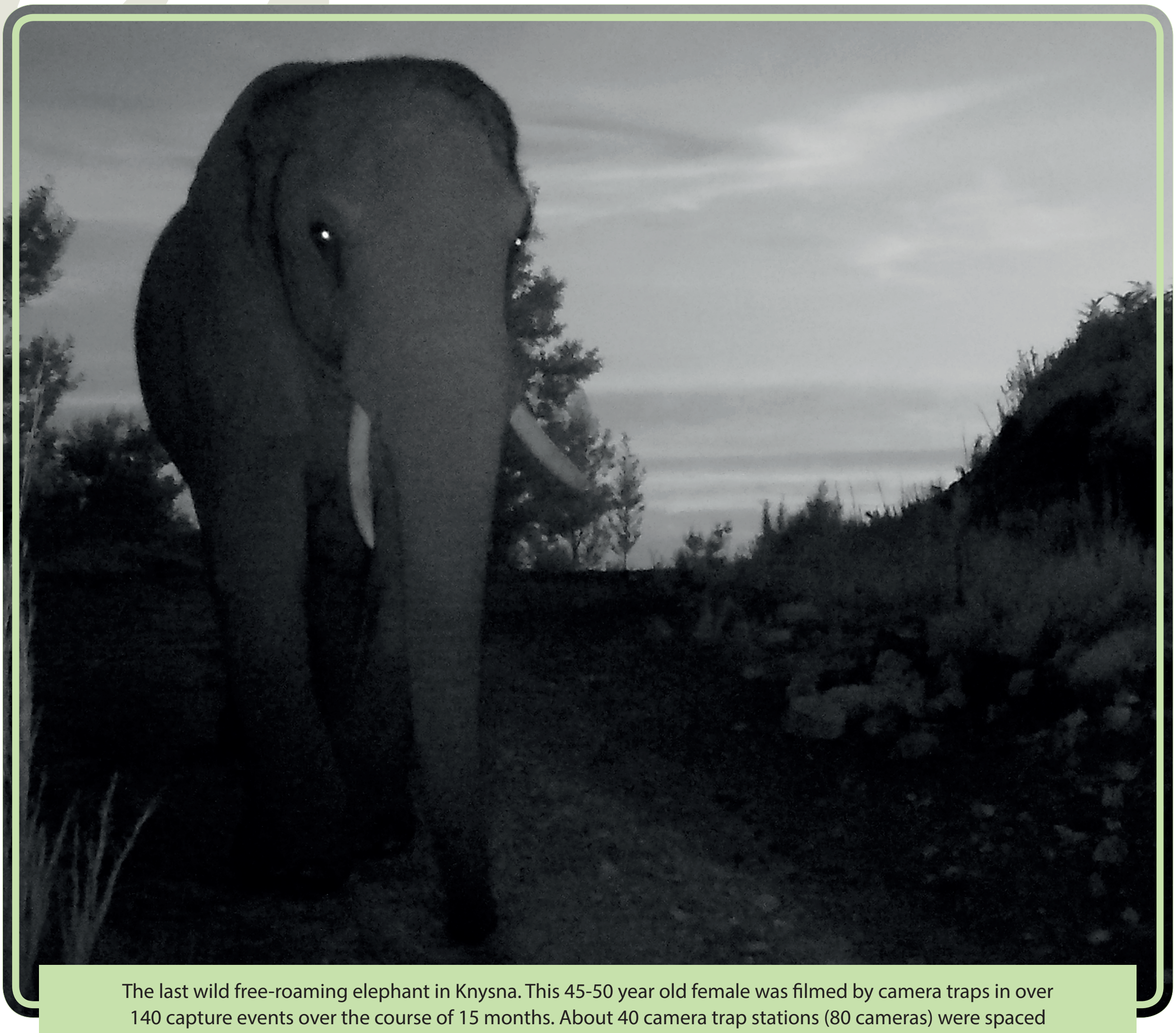
Melanie de Morney

Stefanie Freitag-Ronaldson

Sam Ferreira

Ensuring that wildlife populations or even entire species survive requires a good understanding of how many individuals are left. Counting animals, however, is easier said than done. Different methods of counting carry different challenges and biases and may give contrasting results. At the same time, inexact, unreliable or contested estimates can lead to inaction or inappropriate interventions. Uncertainty and debate around how many individuals are left often create controversy, especially in the case of charismatic species like elephants. The challenges are exacerbated when dealing with small populations of secretive species in low-visibility habitats. A good example of these challenges is the shy Knysna elephant (*Loxodonta africana)* living in extremely low numbers in largely inaccessible mountainous terrain.

The Knysna elephant population became increasingly confined to the dense indigenous forests after settlement of the region by Europeans and declined considerably over the last 150 years. Various attempts to count them show this decline. A scientific approach in 2003 made use of faecal DNA genotyping from dung samples collected in the forest. This study reported that it identified five female elephants and speculated that at least one calf and an adult male must also remain. This result was disputed by forest managers at the time who were monitoring the population through visual and/or incidental signs of their presence. Nevertheless, since then, an on-going debate about the status of the population has raged on, fed by mystique and a diversity of perceptions. The need for a reliable and robust count was mounting. The challenge was on how to do it!



The last wild free-roaming elephant in Knysna. This 45-50 year old female was filmed by camera traps in over 140 capture events over the course of 15 months. About 40 camera trap stations (80 cameras) were spaced evenly across the 185 km^2 elephant range and she was captured across the entire range. © SANParks

Two commonly used non-invasive survey techniques are faecal DNA genotyping and camera trapping. For reliable population estimates from faecal DNA genotyping, dung samples must be less than 24 hours old or the DNA degrades and genotyping error increases, typically resulting in overestimates. Given the rough forest terrain, evasiveness and small population size of the Knysna elephants, it is difficult to get enough fresh good-quality dung samples. DNA genotyping may thus not be the best way to count Knysna elephants. Instead, we used camera traps, which have gained massive support within the scientific community during the last few years. Camera traps now include "invisible" black flash technology which take high quality night-time footage, ideal for very shy animals such as the Knysna elephants.

We conceptualised a study in mid-2016 with the help of experienced field rangers and drawing on the existing spatial database of sightings and signs of the Knysna elephants over the past 30 years. We set up 40 camera trap stations spanning the entire Knysna elephant range. The trap configuration followed scientific guidelines based on elephants' habitual use of trails and roads. We also ensured that gaps between camera stations were small enough to rule out possibilities that an elephant could reside there undetected for the duration of the survey. The cameras were active in-field and took pictures of everything that moved past them for 15 months. During this time, photographs of the same female elephant were obtained during 140 capture events. She was always alone. The cameras did not capture any other elephants. At the end of the survey we left some stations active to continue to monitor the elephant and we still see her regularly.

Our result went public in February 2019 and generated substantial media and public interest. But, what now? This is essentially the last free-roaming elephant in South Africa, and the elephant range crosses multiple private- and state-owned unfenced properties. Thus, SANParks does not own this elephant and cannot decide on a way forward on its own. SANParks has initiated a dialogue process with diverse stakeholders to better understand the values people have around the presence of elephants in indigenous forests. Thereafter, and in conjunction with the prescripts of relevant legislation, discussions on the pros and cons of potential management options for the Knysna elephant will inform a way forward.

The camera trap survey relied on a historical spatial database and local knowledge. With Lizette (middle) are field rangers, locally known as The Elephant Trackers, Karel Maswati (far left) and Wilfred Oraai (far right) who have over 30 years of experience tracking the Knysna elephant. © SANParks

Moolman L, de Morney MA, Ferreira SM, Ganswindt A, Poole JH & Kerley GI (2019) And Then There Was One: a camera trap survey of the declining population of African Elephants in Knysna, South Africa. African Journal of Wildlife Research, 49: 16-26.

Turning up the heat - experimental observations of predicted climate warming on the seagrass, *Zostera capensis.*

Climate-change induced warming is predicted to promote greater declines in the seagrass cover with severe consequences for associated invertebrate communities and knock-on negative effects on other trophic levels in the system.

Cloverley Lawrence

Seagrasses are submerged flowering plants found in many estuaries and coastlines around the world. They form structured habitats that supply food, while also serving as nurseries and refugia, thereby supporting a high diversity of invertebrate fauna that in turn sustain fish and bird populations. Seagrasses have also been identified as a major carbon sink and buffer for global carbon emissions.

Seagrasses are, however, under threat and have declined globally by about 30%. This has mainly been caused by human impacts such as destruction of habitat; through trampling, dredging and anchoring; pollution and reduced water quality, coastal development, harvesting and climate change. In general, climate change raises sea and air temperatures, alters tidal patterns, is responsible for rising sea levels, and escalates flood, storm and cyclone events, all with harmful consequences for seagrass habitats. Daily and seasonal temperature changes affect the temperature range for which seagrasses are adapted, thus influencing their productivity and functioning. Warming can potentially benefit some temperate species, living in below optimum temperatures, while intense and extreme high temperatures for instance from heat waves, negatively affects growth and distribution of these important plants.

As environmental thresholds are exceeded, seagrass populations are forced to acclimatise and adapt or die. One acclimation strategy is a change in form or morphology, to cope with environmental stress such as desiccation (drying out) or low light levels. Understanding the ability of seagrasses to acclimate (adjust their response in a single generation) or adapt (a gradual genetically-driven alteration), is important to understanding how they cope with warming, and determine their continued survival.

Large-leaved (±20.7cm) (A) and small-leaved morphotypes (±8.6 cm) (B) of *Zostera capensis* from Langebaan Lagoon. © A.J. Smit

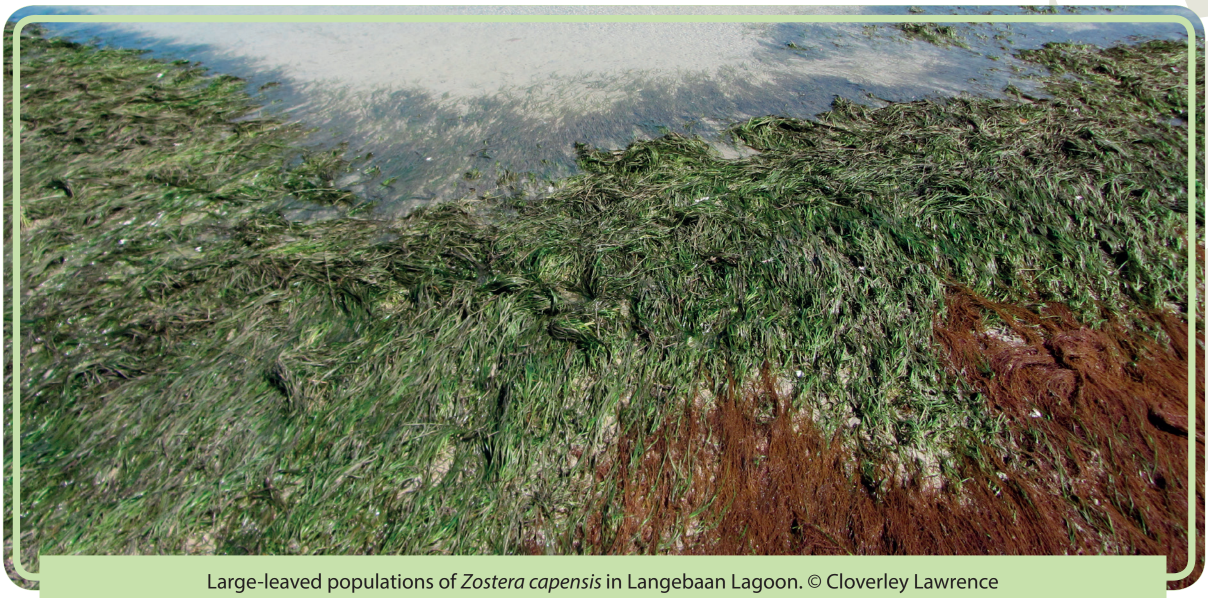
The dominant seagrass in South Africa, *Zostera capensis,* once found in most estuaries and bays, has all but disappeared with only a few extensive stands now remaining - consequently leading to *Zostera* being listed as "Threatened" in the IUCN Red List database. One population is found in Langebaan Lagoon, an intertidal marine lagoon which forms part of the West Coast National Park connected to Saldanha Bay harbour. Mapping studies show high variability in the distribution of *Zostera* in the lagoon with substantial declines in coverage in some years, while field observations found significant spatial and seasonal variability, with severe diebacks in summer. Several factors may be responsible for these declines, including impacts of dredging of the harbour and trampling, possibly while collecting bait, as well as higher summer temperatures. Local environmental variability produced a small-leaved form or morphotype in the upper intertidal zone, and large-leaved populations in low intertidal and subtidal areas, each supporting a distinctly different community of associated invertebrate fauna.

In Langebaan small-leaved populations occur at the head of the lagoon and receive protection from direct human activity through the Park's zonation scheme. Large-leaved populations on the other hand, occur closer to the lagoon mouth where low intensity leisure activities such as surfing, boating and bait collecting are permitted. Climate-change induced warming is predicted to promote greater declines in *Zostera* with severe consequences for associated invertebrate communities, and knock-on negative effects on other trophic levels in the ecosystem.

The study aimed to test the hypothesis that small-leaved populations perform better in response to heat stress than large-leaved populations. This would determine the resilience of seagrass sub-populations to warming and enable predictions of the potential for expansion of seagrass stands under increasing temperature scenarios. Both morphotypes displayed similar structural responses in the decline of leaf size, leaf/shoot densities and biomass in heated compared to ambient temperature treatments. However, physiological differences showed a higher photosynthetic rate and greater accumulations of carbon and nitrogen in small- compared to large-leaved forms under warming. Greater storage of carbon particularly in the root system allows seagrass populations to recover from periodic stressors such as smothering, disease and fouling. Therefore large-leaved populations of *Zostera* are likely more vulnerable to warming and possible threat from disease and fouling, and as a result less resilient than small–leaved populations. These findings align with an earlier study that reported severe loss of large-leaved stands of *Zostera* in Langebaan Lagoon, and highlights the importance of understanding acclimation strategies that allow habitats to persist and maintain productivity and functioning under climate change.

Small-leaved populations of *Zostera capensis* in Langebaan Lagoon. © Cloverley Lawrence

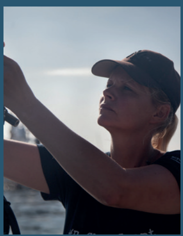
Conservation measures that minimize direct impacts can be effective in protecting seagrass habitats, and possibly enhance their resilience to indirect impacts. Efforts to maintain and restore seagrass habitats both locally and nationally, need to be stepped up to include reducing direct disturbances from human impacts such as trampling, as well as managing indirect impacts such as pollution and harbour-related activities. Raising awareness of the value of seagrasses in sustaining viable marine ecosystems, to many levels of management and governance is also important. In addition, establishing effective monitoring programmes that track variability in seagrass habitats is critical to inform management strategies, and in so doing support the continued provision of their essential ecosystem services.



Large-leaved populations of *Zostera capensis* in Langebaan Lagoon. © Cloverley Lawrence

Shining a spotlight on sharks: towards better understanding important ocean predators

Strong collaborations on shark ecology research resulted in five publications this year pertaining to monitoring techniques, shark behaviour, physiology and movement, predator-prey interactions and future research directions



Alison Kock

Sharks have not traditionally received as much research attention as marine mammals and commercially important fish species. However, the important role of sharks in the structure and function of marine ecosystems through regulation of prey population size and behaviour has seen increased interest in their ecology and conservation. Collaborations between SANParks and 54 scientists from >70 local, national and international institutions resulted in five shark publications in 2018/19 alone.

Photo identification of individual sharks

Scientists are continuously looking to employ research methods that are cost efficient, applicable to numerous individuals and that have low to no impact on study species. Recognizing individuals within a study species is a fundamental requirement for population biology and demography research. Many species of sharks and rays have natural differences in colour patterns, counter-shading (i.e. cryptic colouration of an animal with a dark dorsal surface and light ventral surface) and fin notches which can be used to reliably identify individuals over time. Photo-identification is the "recognition of individual animals through their distinctive natural markings, recorded via photographs or video" and is increasingly being used by scientists to study residency and movement, population size and demographics and social behaviour. We reviewed the application of these methods for sharks to highlight the advantages, limitations and future directions. Benefits of the methodology include it being non-invasive, reliable over time, cost effective and accessible to citizen scientists, allowing them to participate in research. The method is however limited to sharks and rays that have stable, unique features for identification.

Great white sharks have distinctive notches on the trailing edge of their dorsal fins which can be used to reliably identify individual sharks for up to 20 years. © Alison Kock

Pierce SJ, Holmberg J, Kock AA & Marshall AD (2018) Photographic Identification of Sharks. In: Shark Research: Emerging Technologies and Applications for the Field and Laboratory (Eds Jeffrey C Carrier, Michael R. Heithaus, Colin A. Simpfendorfer). CRC Press.

Shark behaviour and physiology

Great white sharks are famous for breaching out of the water to capture agile Cape fur seals. As the largest of the predatory sharks (6 m total length), coupled with being endothermic, this behaviour is not unexpected. On the other hand, basking sharks (10 m total length) are ectothermic filter-feeders and traditionally thought of as slow and lazy. Our research challenged this perception of the physiology of these large filter-feeders. By using a combination of video footage of breaching white and basking sharks, and biologgers attached to basking sharks we demonstrated that basking sharks breach completely out of the water at similar vertical speeds to great white sharks (18 $km.h^{-1}$). However, for basking sharks, breaching comes with a higher energetic cost and subsequent recovery time, almost double that of a great white shark. Our results also demonstrate that similar body designs can be well suited to very different lifestyles.

A basking shark breaching off the coast of Ireland. Exactly why basking sharks breach still remains a mystery, but it may serve to communicate dominance, attract mates, get rid of parasites, aggregate prey or evade predators. © Bren Whelan/Dongal Climbing

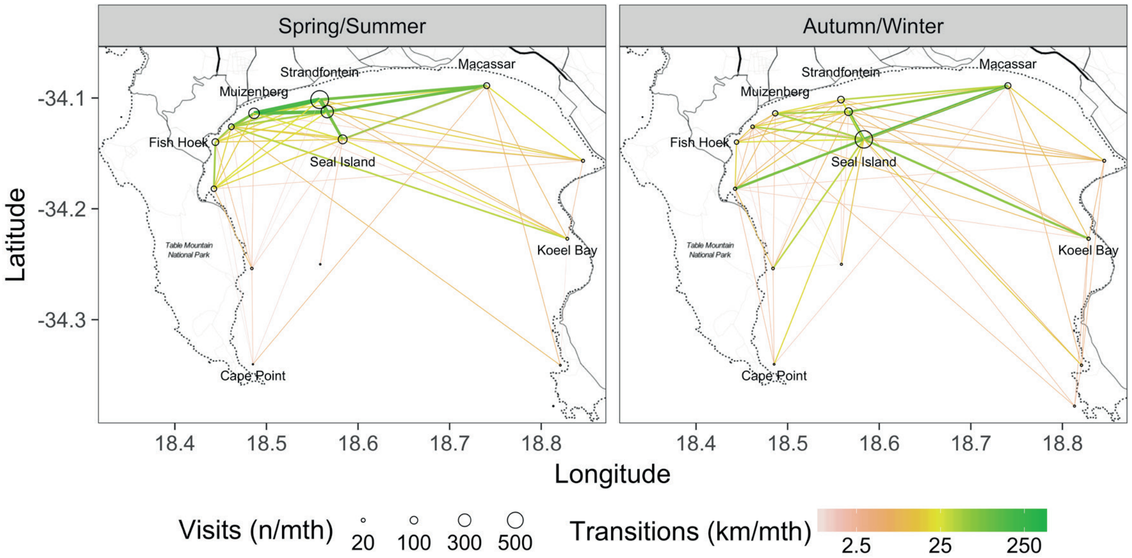
Johnston EM, Halsey LG, Payne NL, Kock AA, Iosilevskii G, Whelan B & Houghton JDR (2018) Latent power of basking sharks revealed by exceptional breaching events. Biology letters, 14 (9), 20180537. https://doi:10.1098/rsbl.2018.0537

Kock AA, Photopoulou T, Durbach I, Mauff K, Meÿer MA, Kotze D, Griffiths CL & O'Riain MJ (2018) Summer at the beach: spatio-temporal patterns of white shark occurrence along the inshore areas of False Bay, South Africa. Movement Ecology, 20186:7. https://doi.org/10.1186/s40462-018-0125-5

Shark movements

Understanding the movement and habitat use of great white sharks is essential for devising improved conservation and management strategies for these vulnerable predators. Fifty-one sharks were tagged with acoustic transmitters and monitored on an array of tracking receivers in False Bay, Cape Town. We found that sharks visited specific inshore sites between Muizenberg and Strandfontein beach most frequently, there was higher shark occurrence around midday, and a peak in occurrence in 2005, when human-shark interactions also peaked. It is recommended that these sites be included in Table Mountain National Park marine protected area and/or recognition as Ecological or Biological Significant Areas in marine spatial planning.

A tagged great white shark at Seal Island, False Bay. © Alison Kock



Sharks occurred more frequently at inshore sites during spring and summer months, and along the northern and northwestern shores of False Bay, compared to the rest of the bay. Sharks transitioned most frequently between four adjacent beach sites that encompass the most popular recreational water use areas in Cape Town, highlighting the need for ongoing shark safety and awareness to mitigate conflict.

Predator-prey interactions

Sevengill sharks are large, coastal sharks that feed on Cape fur seals, other sharks and fish. One of the most popular SCUBA dive sites in the world used to be inside the Table Mountain National Park marine protected area, where up to 70 of these sharks could be encountered on a single dive. This all changed with the arrival of a pair of shark eating killer whales. These killer whales selectively ate the energy-rich livers of the sharks and left the rest of the carcass on the seafloor. Besides being a novel predator-prey interaction for South Africa, the bigger impact of these predation events was that the sevengill sharks fled the area and abandoned the aggregation site, demonstrating the large impact apex predators have on shaping ecosystems.

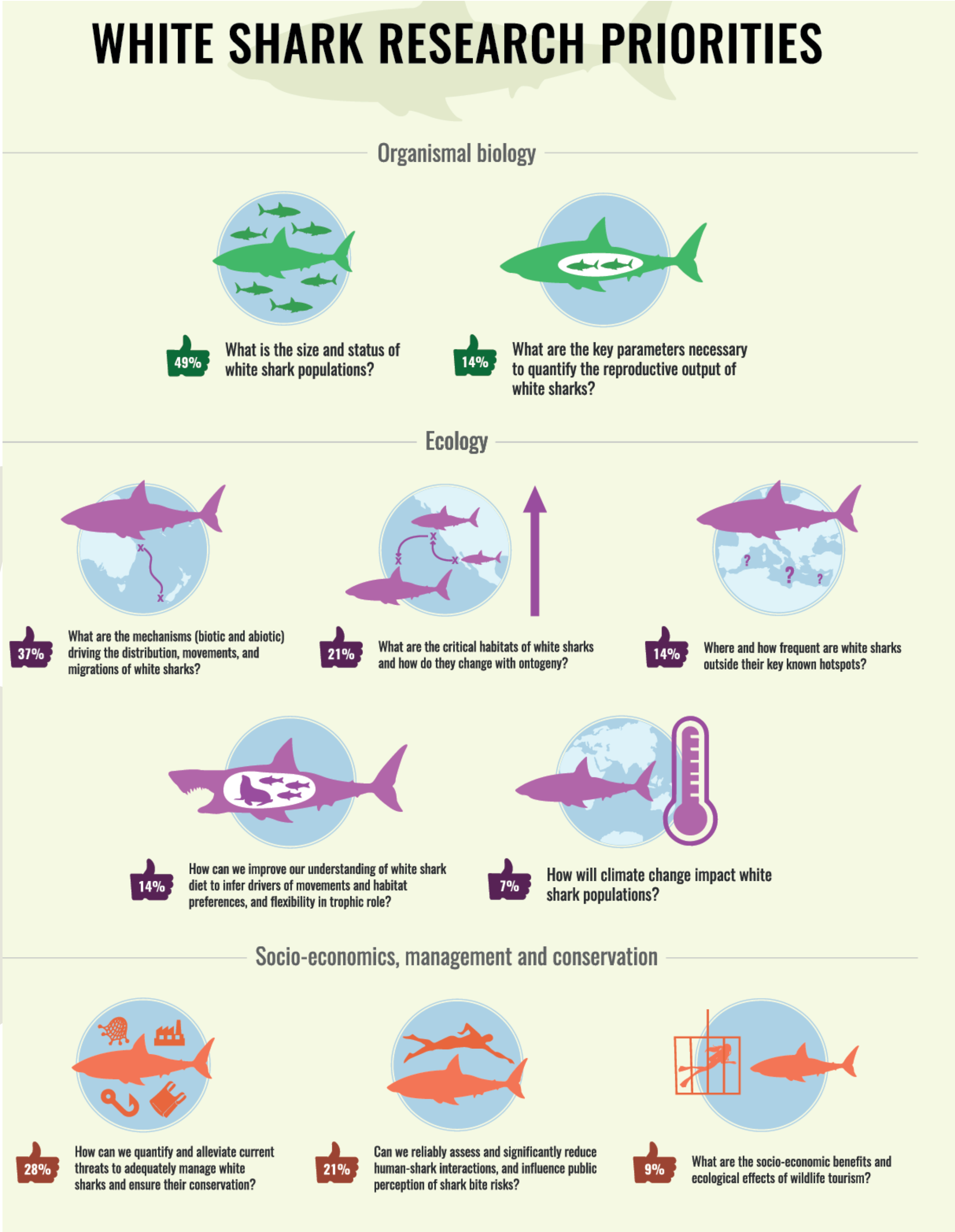
A pair of male killer whales, nicknamed, Port and Starboard (because their dorsal fins bend over to the left and right respectively) are the prime suspects in the deaths of several sevengill sharks at Millers Point, TMNP. © Alison Kock

Bite and tooth impressions found on several sevengill shark carcasses revealed that the killer whales had bit onto the pectoral fins and ripped open the body cavity to access and consume the energy-rich liver. © Alison Kock

Engelbrecht TM, Kock AA & O'Riain MJ (2019) Running scared: when predators become prey. Ecosphere, 10 (1). https://doi.org/10.1002/ecs2.2531

Huveneers C., Apps K, Becceri-Garcia EE, Bruce B, Butcher PA, Carlisle A, ... Kock AA...et.al. (2018) Future research directions on the "elusive" white shark. Frontiers in Marine Science, 5, 455. https://doi.org/10.3389/fmars.2018.00455

Future research priorities for great white sharks



The top ten future research priorities for great white sharks determined by 43 scientists and managers from around the world. To date South Africa's rich history of great white shark research has been evidenced in the ~20% of scientific publications on the species originating from this region. Scientists and managers generally agreed on research priorities, except for the theme "public perception and media portrayal" which was prioritised by managers, but not scientists. Greater collaboration among scientists, and between scientists and managers to channel limited resources to the most pertinent questions is a key priority.
Scientific infographic by David "Ed" Edwards—www.dgedwards.com.

SANParks will continue to play a major role in research and monitoring of threatened sharks in South Africa. Currently, research is being conducted across several marine protected areas and coastal parks, using a combination of photo-identification, baited remote underwater video-camera surveys (BRUVs) and animal tracking to better understand the ecological role of these ocean predators and the growing pressures they face.

Widespread exposure to poison in urban predators

Mammal and bird predators living in urban areas are exposed to rat poisons at alarmingly high rates (>90% exposure for caracals) which although tolerated by many species, adds an additional risk factor to species already faced with a litany of threats

Pesticide exposure is a leading threat to biodiversity worldwide and toxicants used by people often kill wildlife species indiscriminately. Although unintended, pesticide exposure can influence population dynamics and potentially escalate to ecosystem level impacts, if toxicant exposure affects numerous species across trophic levels. Anticoagulant rodenticides (AR; rat poisons) are the primary chemical method used to control rodents across the globe and cause death by internal bleeding up to 10 days after lethal dose ingestion. Rat poisons are known to bio-accumulate across the levels of the food chain and therefore threaten non-target species.

We investigated the prevalence of rat poison exposure in seven predator species within the Cape Town district from a mixture of natural, urban and agricultural areas. The study also aimed to assess whether spatial, temporal and demographic factors influence caracal risk of exposure. Sampling was focussed on caracals (n = 28) as it was part of a larger caracal ecology study where caracals were captured and fitted with GPS enabled radio-collars. Liver samples were collected from collared caracals which died during the study, as well as opportunistically collecting carcasses of those killed by motor vehicles. Samples were also obtained from cape clawless otters (n = 9), large-spotted genets (n = 4) and one honey badger, water mongoose, small grey mongoose, and cape eagle owl obtained opportunistically from roadkill. Samples from all species were tested for eight rat poison compounds to determine the amount of exposure and prevalence of each compound. For caracals, we also tested spatial, demographic and seasonal risk factors of AR exposure using generalized linear models.

At least one of the four most toxic AR compounds was detected in six species. Exposure was high for caracals (92%) and 81% across all species. Multiple compounds were detected within individual caracals, genets and the cape eagle owl. The highest concentrations of rat poison were detected in two genets (Fig. 1) and proximity to vineyards was a critical exposure risk factor for caracals.

While vineyards do not use rat poisons to protect their crops, they do host commercial hospitality businesses where rat poisons are used and may thus provide a pathway of exposure between caracals that forage in vineyards and the poisons used at commercial structures. Large spotted genets thrive in urban areas and are generalist omnivores that feed primarily on rodents and invertebrates. While rat poisons are considered non-toxic to invertebrates, invertebrates (e.g. cockroaches) can accumulate lethal levels after prolonged exposure. This may explain the high AR concentration levels found for genets. However, it seems that genets are capable of high levels of accumulation without showing adverse effects, as is the case with some felids. A surprising result was that 50% of cape clawless otter were exposed to rat poisons. This suggests that otters may also be directly exposed via contaminated water or invertebrate prey affected by contaminated water since many of these water bodies are located close to formal and informal settlements where rat poisons are known to be broadcast by hand. Rat poisons have also been detected in marine vertebrates and invertebrates after island rodent eradication programs and thus it is possible that poison baits can travel to aquatic systems via surface run-off.

Species vary in their sensitivity to the effects of rat poisons. Some species are vulnerable to the effects and can die directly from exposure while others are tolerant and can withstand sustained sub-lethal exposure. Nevertheless, rat poisons can be an important contributor to mortality and may be an overlooked threat to wildlife populations already vulnerable to habitat loss, vehicle collisions, poachers and fire. Targeted mitigation should include a mix of environmentally responsible policies that reduce the use of rat poisons, particularly in areas near wildlife habitat.

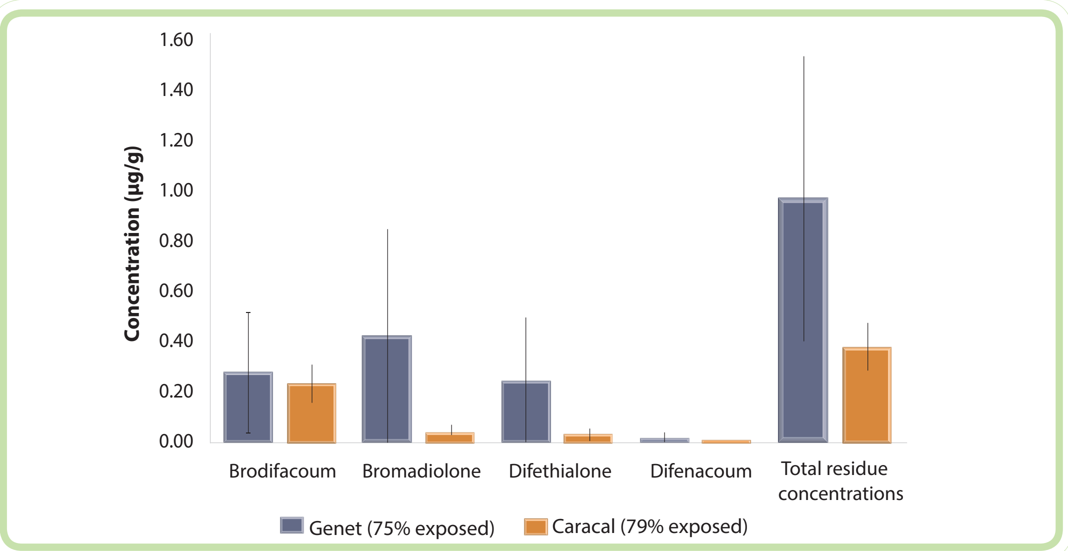
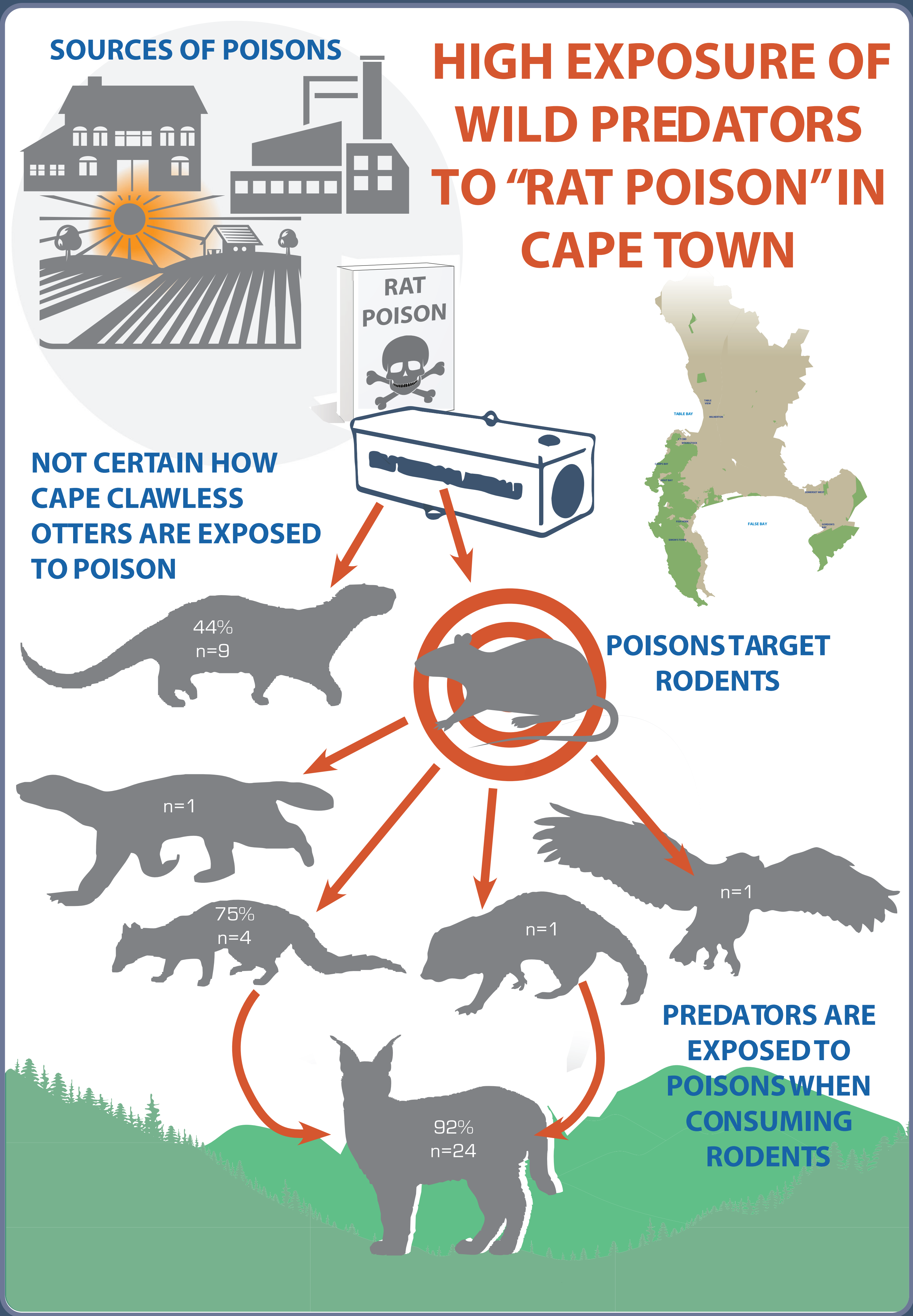


Figure 1. Average residue concentrations of the four main anticoagulant compounds detected in genets (n = 4) and caracals (n = 24). Anticoagulant compounds were only detected in trace amounts in samples from four otters.

Deborah Winterton

Laurel Serieys

Reference
Serieys LE, Bishop J, Okes N, Broadfield J, Winterton DJ, Poppenga RH, Viljoen S, Wayne RK & O'Riain MJ (2019) Widespread anticoagulant poison exposure in predators in a rapidly growing South African city. Science of the Total Environment, 666: 581-590.


SOURCES OF POISONS
HIGH EXPOSURE OF WILD PREDATORS TO "RAT POISON" IN CAPE TOWN
RAT POISON
TABLE BAY
FALSE BAY
NOT CERTAIN HOW CAPE CLAWLESS OTTERS ARE EXPOSED TO POISON
44%
n=9
POISONS TARGET RODENTS
n=1
75%
n=4
n=1
n=1
92%
n=24
PREDATORS ARE EXPOSED TO POISONS WHEN CONSUMING RODENTS


© Alison Kock

RESEARCH OUTPUTS

© Laurence Kruger

Judith Botha

Chenay Simms

Science in SANParks
Peer reviewed journal articles and conference attendance

Presenting research findings conducted during the course of a year at conferences, or as peer reviewed publications in journals or book chapters, ensures that the knowledge that is generated within SANParks is shared with the larger scientific community.

For the year April 2018 until March 2019 a total of 123 peer reviewed articles and book chapters were published by both internal SANParks staff and external researchers on research conducted in the SANParks protected areas. SANParks staff was either lead author or co-author on 57 of those articles (46%), showing the productivity of the group. Of the 57 internally authored articles in 2018/2019 SANParks staff members were lead author on 14 and co-author on 43 (this differs slightly from the official reported numbers due to late submissions (Fig. 1)).

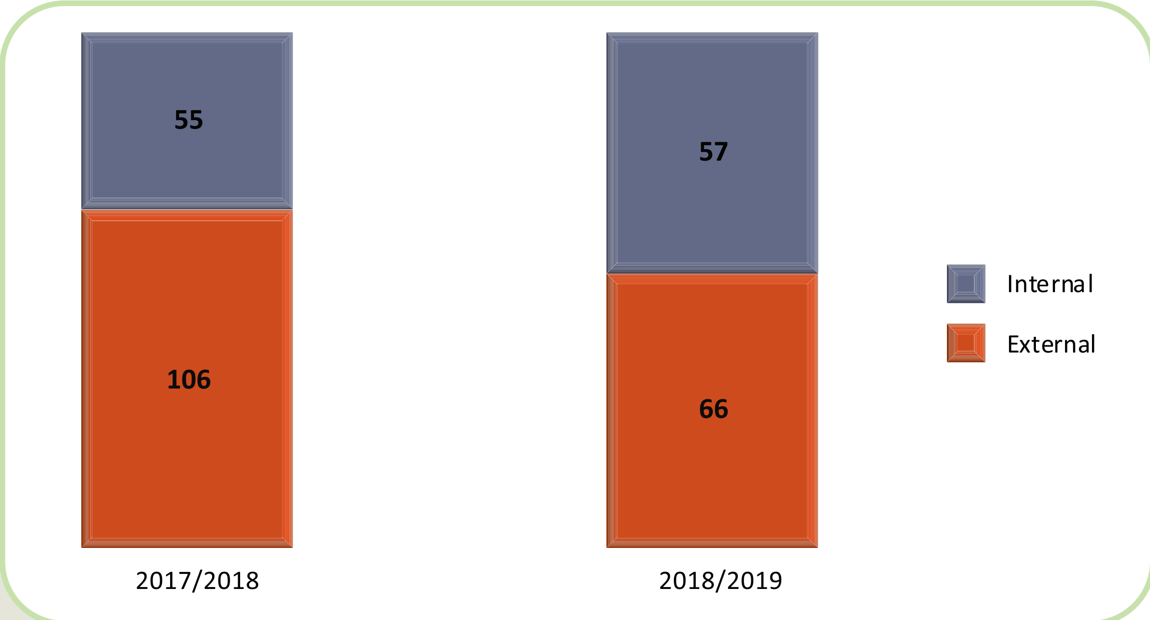


Figure 1. Affiliation of the authors of papers published on SANParks protected areas for the 2017/ 2018 and 2018/2019 reporting periods. Internal refers to papers with a SANParks affiliated author.

In 2018/2019 articles were published in 43 different journals with the largest number being in Koedoe and Plos One. A good spread was seen across local and international journals, highlighting that SANParks science is reaching a wide and varied scientific audience. Ninety three of the articles published, were in peer reviewed journals with an Clarivate Analytics impact factor with twenty eight articles published in journals with Impact scores > 3 (Fig. 2). The remaining twenty four articles and six book chapters accounted for publications in "non-rated" journals.

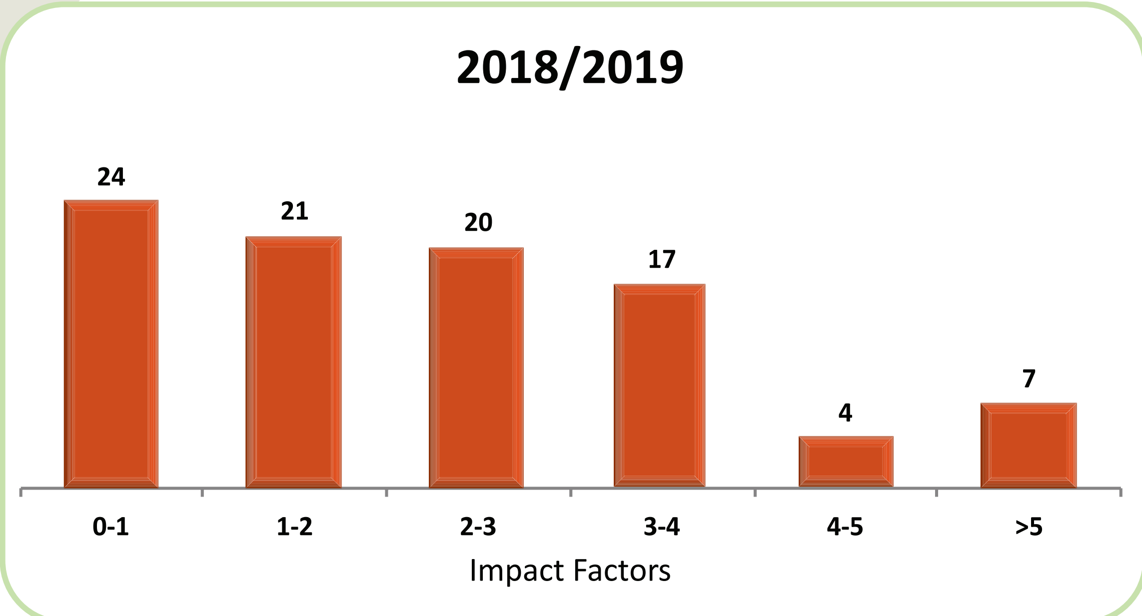


Figure 2. Journal impact factors of papers published on SANParks protected areas.

The distribution of articles published per park in 2018/19 was very similar to the previous year (Fig. 3). Whilst there were many more publications in Kruger and the Garden Route National Park in 2017/2018, in 2018/2019 the smaller parks that previously had no publications, like Tankwa Karoo, showed an increase in publications. These are natural variability as expected between years. In total 14 of the parks had journal articles published from work done in the parks with 11 articles from studies across multiple parks. The 23 publications in the 'Other' category included SANParks authors but were not specifically associated with a particular park. This year the Marine related articles were included in the park totals as opposed to 2017/2018 where they were treated as a standalone category.

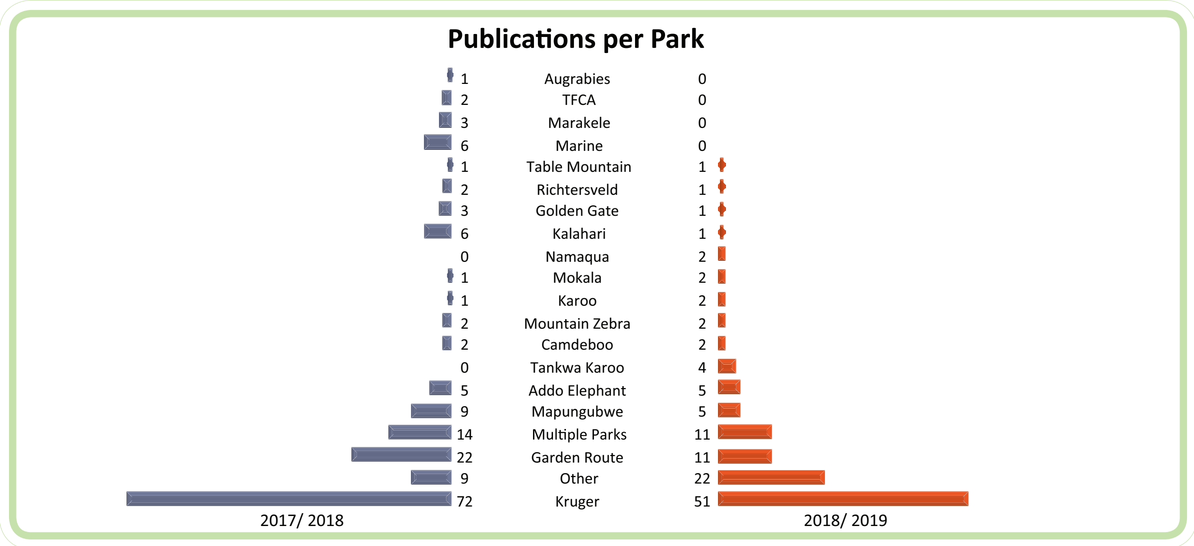


Figure 3. Number of papers published for the various SANParks protected areas – April 2017 till March 2019

During the past year SANParks staff presented either oral presentations or posters at 39 conferences, 28 of these were at National Conferences and 11 at International conferences (Fig. 4). The Garden Route Interface meeting and the International Savanna Science Networking meeting (SSNM) are both hosted by SANParks and form an important part of knowledge exchange between scientists and researchers doing work within SANParks. Eight presentations with SANParks as lead author were given at the Garden Route Interface meeting and four were given at the SSNM and many more staff were co-authors of presentations at these two meetings.

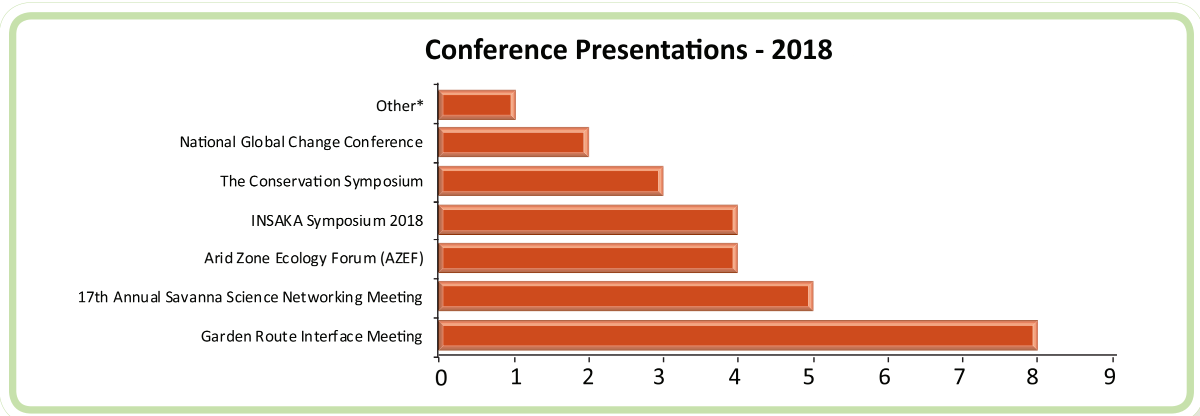


Figure 4. Platform Presentations given at National and International conferences by SANParks staff – April 2018 till March 2019 (* 19th Marine and Coastal Educators Network Conference,1st SADC Groundwater Conference, 40th Fynbos Forum, 45th Symposium on Management of Biological Invasions, African Rhino Specialist Group,European Association of Zoos and Aquaria, Grassland Society of Southern Africa Annual Symposium, SAEON Indibano (student conference) SANCIAHS Hydrology Symposium, South African Wildlife Management Association Conference, SPARC AfricanRegional meeting, Stockholm Seminars, Sustainability Research Unit (SRU) Associates Symposium)

In addition to formal conferences SANParks staff were also involved in many workshops, forums and invited presentations. Peer review of journal articles and examination of theses are some of the ways SANParks staff gives back to the larger scientific community. In total 46 peer reviews of journal manuscripts were performed, 16 external postgraduate dissertations were examined and 12 editorial roles for scientific journals performed.

Information sharing to the general public took place in the form of popular articles and interviews for press, radio and television. Future plans for getting key messages across to the general public focus on online resources, such as blogs, videos and social media platforms. This will allow SANParks science communication to reach a wider audience more easily and efficiently.

Stef Freitag-Ronaldson

Izak Smit

Dirk Roux

Danny Govender

Shaping and developing a research strategy for SANParks

The past year saw significant energy invested and progress made towards the development of an overarching and guiding research strategy for SANParks. The strategy, currently in final draft form, will facilitate and enable the generation, improvement and sharing of knowledge, information and experience. It further aims to build organisational capacity to more effectively manage biodiversity and share appropriate opportunities and benefits in and from national parks in an ever changing socio-ecological context. It underlies the ethos of adaptive management and encourages learning through doing by monitoring, evaluating, reflecting and reporting progress. At the same time, it recognises that adequate capacity, resources and enabling as well as supporting infrastructure underpin effective implementation of biodiversity and social-ecological research and monitoring.

Initial workshops in Skukuza and Rondevlei involved most SANParks scientists and biotechnicians. They were required to think outside of their comfort zones in a process of horizon scanning for the most critical influences, drivers and risks for SANParks in the medium term (5-10 years). Based on this process, eleven broad research themes were identified. As a second phase, and based on the horizon scan and theme articulation, a questionnaire was distributed to senior and middle managers within the organisation. Seventy-nine completed questionnaires were received from 13 national parks, 3 regional offices and various corporate colleagues. In total, these covered staff from 11 different departments (park managers, conservation and ranger services, tourism and hospitality, people and conservation, corporate/regional, biodiversity social projects, finance, park planning and development, governance, scientific services). Respondents were asked to rank potential influences on SANParks at two scales, namely nationally/organisationally and at park level.

From the survey it is evident that, within the organisation, scientists and non-scientists are largely in agreement on the most important influences faced by the organization going forward (Fig. 1). The five major influencers were considered to be climate change (and large infrequent disturbances), human population growth and resource scarcity, national socio-political and economic processes (including land restitution), illegal activities inside and outside parks, and changing societal expectations of what parks are about and the relevance of conservation. Results reflect the reality that issues considered more important on the SANParks level relate to larger-scale, national, organizational and societal processes whereas issues considered more important at the local scale are often operational aspects experienced at the park level. Differences in "importance rating" between the SANParks scale and park/region scale provide some guidance in terms of appropriate scales for researching various issues.

The SANParks Research Strategy will provide a strategic framework and principles to strengthen and direct internal and collaborative research practices. The key objectives of this strategy are to outline and articulate (a) the approach and principles underpinning research and research collaboration within and in conjunction with SANParks; (b) how the internal research function of SANParks seeks to support and influence strategic planning, implementation strategies and monitoring and evaluation activities; (c) pertinent research themes, linking across multiple scales, requiring specific attention and focus in the next 10 years, acknowledging the dynamic nature of research; and (d) enabling conditions for research in the SANParks context.

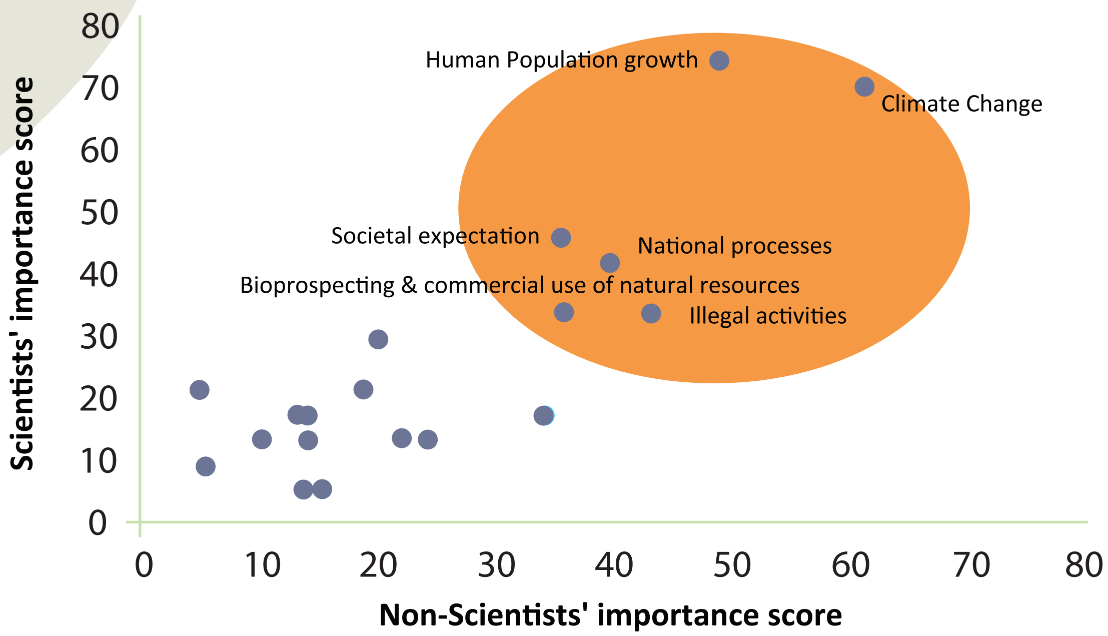


Figure 1. Scientist and non-scientist SANParks colleagues agreed on the top six most important influences facing SANParks in the next 10 years (encircled in orange). Many of these influences are beyond the direct control of SANParks, yet mitigation, adaptation and preparation may be possible.

Koedoe – advancing a scientific journal to capture conservation management evolution

Marna Herbst

Danny Govender

On the 60th Anniversary of the SANParks in-house journal Koedoe, Jane Carruthers and Llewellyn Foxcroft reflected on its rich history, celebrating 6 decades of publications that have shaped our collective understanding of conservation science and management paradigms in Protected Areas.

Even in the early years as a National Parks Board scientist-led annual publication, Koedoe allowed for the exchange of knowledge in and out of National Parks, establishing productive research networks that would uncover and define unique biodiversity and ecosystem functioning, but also allow for the application of scientific evidence for decision making in SANParks. The Journal would eventually come of age in 2013, as a highly respected, peer-reviewed, open access journal, with its first impact factor rating of 1.48.

Reflecting on just more than a dozen past articles of the 1250 that have been published, they highlight the various management eras and the shifting the focus of conservation in South Africa and SANParks. From its early years of descriptive and species inventory-type research, mostly on mammals, but also geology and vegetation, to the 1987 systems view article by Peter Novellie on the inter-relationships of fire, grazing and grass-cover in Bontebok National Park, to the special issues on Adaptive management (2011), and Tourism in Protected areas (2014), the journal has published content reflecting the issues that the organisation was grappling with and/or celebrating at the time. It has served not only to capture the discourse regarding some of the most pressing conservation challenges, but has also allowed for a space for protected area managers and scientists to deliberate/contemplate the complex socio-ecological systems in which protected areas are nested.

Table 1. Status of manuscripts (all categories) submitted to Koedoe between 2008 and 2018. Koedoe data are per calendar year (excluding Jan-March 2019).

Type	2008	2009	2010	2011a	2012	2013	2014b	2015	2016	2017	2018
Total submissions	39	37	51	25	42	48	34	61	52	41	39
Manuscripts **accepted**			13	30	16	28	10	17	26	22	9
Manuscripts **declined**	21	23	35	25	22	58	25	37	26	28	15
Articles published	20	12	10	32	17	22	21	21	18	29	17

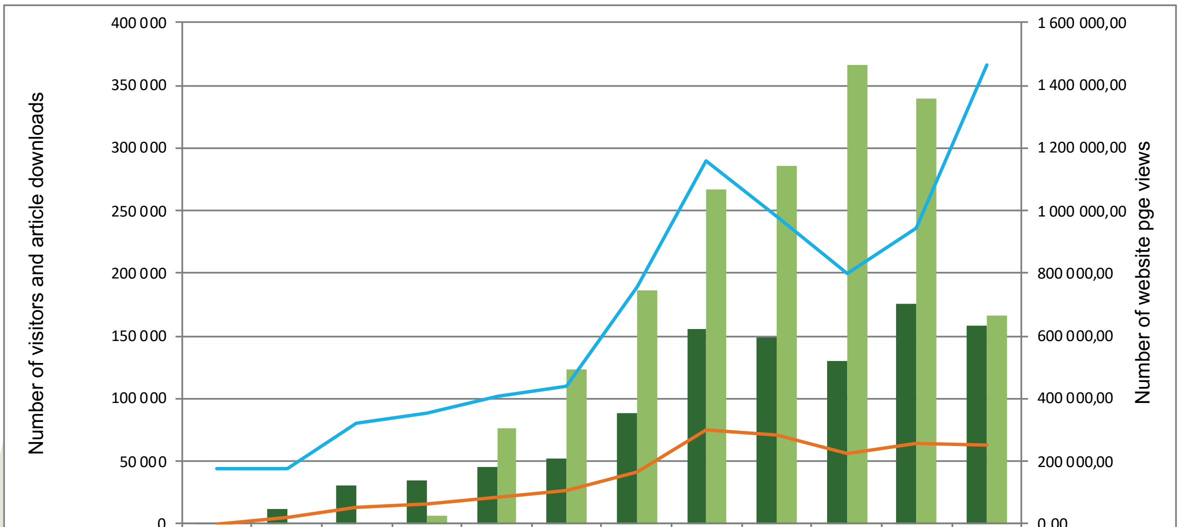
a Includes Special Issue on Adaptive Management, Vol. 53(2).
b Includes Special Issue on Tourism, Vol. 56(2).

In the sea of scientific journals now on offer, Koedoe has stood the test of time and will continue to be a beacon of excellence in protected area science.

The overall number of page views on the Koedoe website continued to grow from ~180,000 in 2007 to the current ~1 400,000 page views. The number of first time visitors to the Koedoe website has remained relatively stable since 2014. The drop in number of article downloads may be a consequence of articles being indexed and downloaded from other platforms (Fig. 1).

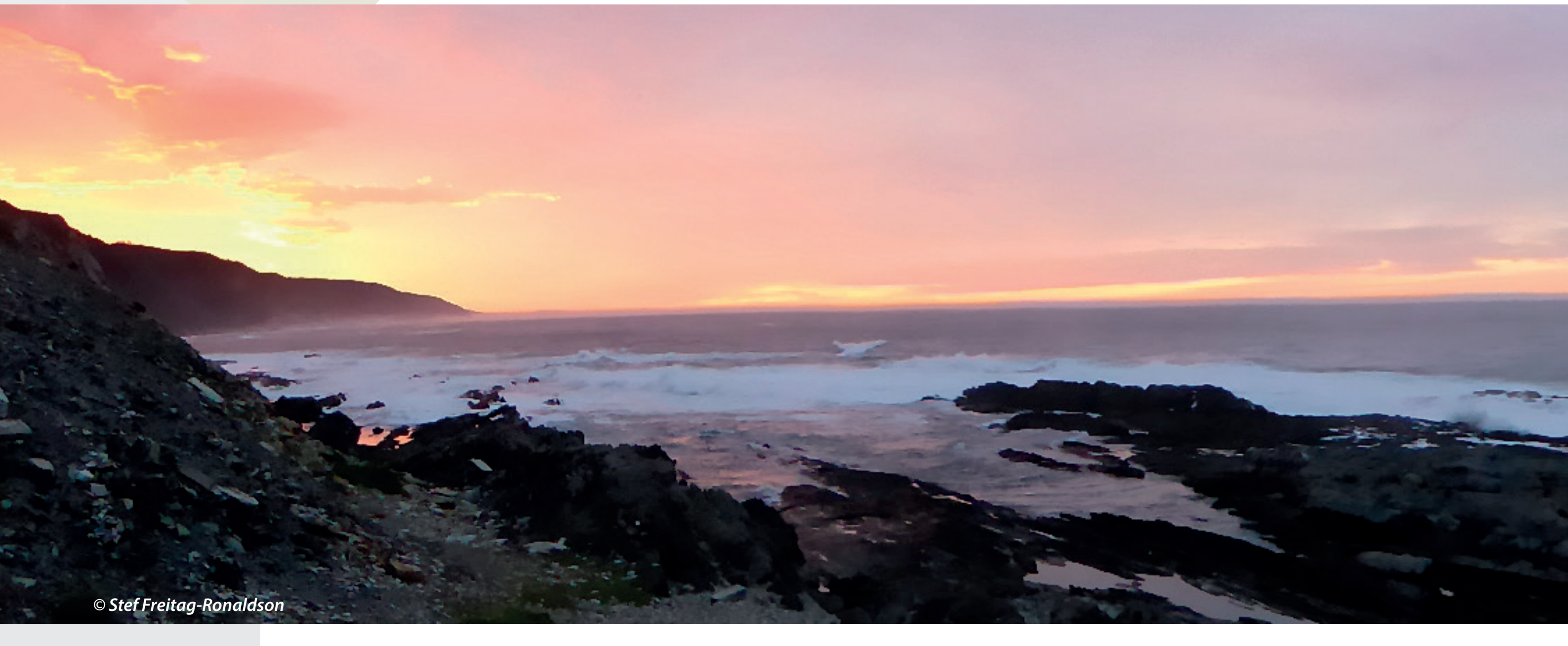
Koedoe statistics

The number of submissions in 2018 remained similar to the previous years, with 39 manuscripts submitted. Submissions appear to increase in the years following the publication of special issues (2011 and 2014). 17 articles were published in 2018 (Table 1). To improve the long-term standing of the journal an increase in high-quality submissions is needed.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Unique Visitors	20	12602	30628	35383	45236	52882	87836	156141	149425	130682	175659	158006
Downloads				6356	76987	122819	186764	267546	285478	365890	339440	165937
No. of visitors	52	19919	54008	62814	87004	105654	163617	301408	281700	226333	259458	253473
Page views	178957	178957	323395	353619	408309	437987	756880	1158415	979519	797460	943484	1464186

Figure. 1. Number of visitors and articles downloaded between 2008 and 2018 from the Koedoe server; unique visitors refers to first-time visitors to the website; number of visitors includes repeat visits. Koedoe data are per calendar year (excluding Jan-March 2019).



Research projects registered within SANParks

As custodian of South Africa's national park estate, SANParks makes use of engaged science to produce reliable and relevant information that can contribute to the responsible management and conservation of its assets. As such, SANParks' in-house researchers co-learn with other national and international researchers as well as with conservation planners, practitioners, policy makers and the public. Such socially engaged science promotes knowledge exchange as the focus shifts from knowledge transfer to knowledge co-production. The number of management relevant research projects registered with SANParks is one of the key indicators of this engaged science.

In total, 78% of the 314 registered research projects in 2018/19 were rated as essential and/or important to SANParks key issues, aligning with research themes identified in the draft SANParks research strategy. These research projects relate to themes such as ecosystem structure, function and process, ecosystem services, sustainable use, global environmental change, adaptive governance, cultural heritage, integrated land-use and effective (Fig.1) social engagement. SANParks-embedded scientists were demonstrated to play a key role as facilitators and leveraging agents of external research effort to meet organisational knowledge needs.

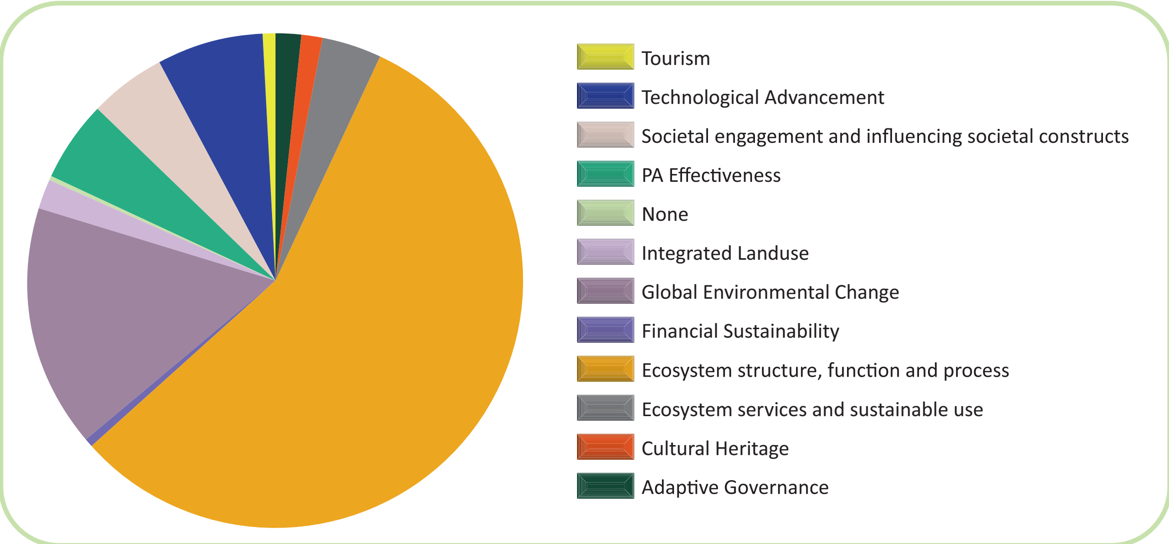
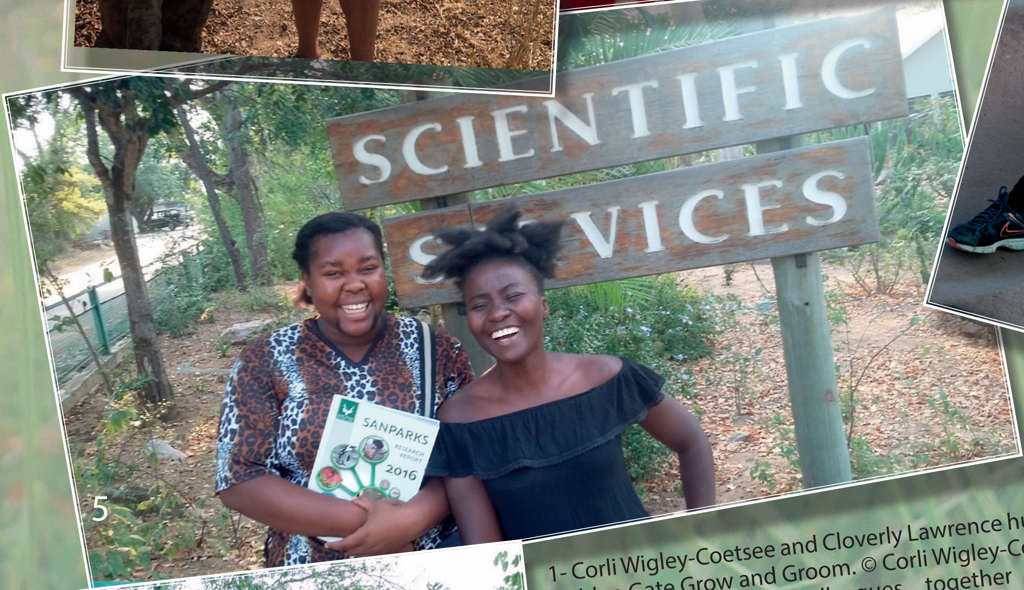


Figure 1. Registered research projects for 2018/19 according to research themes.

Danny Govender

Stef Freitag-Ronaldson


OUT
AND
ABOUT
© Morne Hardenberg



1- Corli Wigley-Coetsee and Cloverly Lawrence hunting fossils during the Scientific Services Golden Gate Grow and Groom. © Corli Wigley-Coetsee
2- Scientific Services colleagues, together with the Head of Scientific Services (Danie Pienaar) and the Managing Executive (Luthando Dziba), testing tracking tools on crocodiles in order to better understand ecosystem health in the lower Olifants river, where crocodile mortalities abound some years ago (Photo: SANParks)
3- Sam Ferreira and KNP Ranger Marius Snyders discussing elephant management. © Corli Wigley-Coetsee
4- Hard at work writing those first academic manuscripts ever…….and taking a break in the Shingwedzi river after a long day of writing. © Izak Smit
5- Nthabeliseni Munyai and Nelsiwe Mpapane enjoyed their time on the Organization for Tropical Studies' programme as part of their induction in Scientific Services. © Izak Smit
6- Mopane worm harvesting with local communities in Shangoni ranger section in KNP (photo: SANParks)
7- SANParks management, scientists and stakeholders participating in field visits and discussions during an estuary management course presented by Nelson Mandela University in the Garden Route in March 2018. © Jessica Hayes


7


8


9


11


10


12

13

8- One of the various park management plan meetings, this one being internal, held in the Garden Route during 2018. © Jessica Hayes
9- Pieter van Wyk measuring the height of quiver trees in the Richtersveld NP. © Wendy Foden
10- Sisanda Mayekiso counting limpets during rocky shore monitoring in Namaqua National Park © Alison Kock
11- Bheki Maphanga, setting nets on the Wilderness Lakes as part of the annual fish community assessment. © Kyle Smith
12 - Louise Swemmer at workshop to distribute medicinal pepperbark trees and discuss the planting and usage of these trees with traditional healers at Nkambeni village outside KNP © SANParks
13 -Ndiviwe Baliwe enjoying sea-based fieldwork in False Bay © Alison Kock
14 -Nelson Mandela University Conservation student, Abongile Malgas, and SANParks rangers measuring fish caught during the annual fish community assessment on Touw Estuary. © Kyle Smith


14

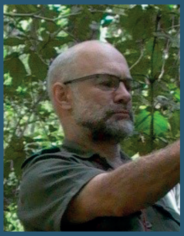
STAFF NEWS

© Kyle Smith

Although 2018/2019 saw various new appointments in Scientific Services, we also had some colleagues retire or taking up new opportunities in other organizations.

Stef Freitag-Ronaldson

Johan Baard



Graham Durrheim

Celebrating a career spanning more than three decades in forest conservation: Wessel Vermeulen retires

Dr Wessel Vermeulen took early retirement at the end of March 2019 after a career spanning more than 30 years in the conservation of the forests and fynbos of the Garden Route. Wessel's career began at the Forestry Directorate at the Department of Environment Affairs in Pretoria, after completing a BSc Forestry degree at Stellenbosch University. After completing BSc(Hons) at the University of Pretoria, and longing to escape the big city, Wessel transferred to Knysna in January 1989. He headed the Indigenous Forest Planning section, enjoying the field and scientific aspects far more than his administrative responsibilities. Wessel spent a number of years guiding the development of scientific management systems for the Amatole indigenous forests of the Eastern Cape before pursuing his MSc and PhD studies. Wessel joined SANParks' Scientific Services team in 2005, with the transfer of the management of indigenous forests from the Department of Water and Forestry (DWAF) to SANParks.

Wessel with his "wat sal ek sê" smile. © Melanie de Morney

Wessel's gift and passion for connecting with and caring for animals, expressed here on Mandela Day in 2016. © Jessica Hayes

Wessel has retired early to devote more time to his other interests, specifically animals and travel. Wessel is a long-standing volunteer at Knysna Animal Welfare and completed courses in animal psychology. Despite a large assortment of pets at home, Wessel and his wife Cobri frequently doctor, foster and nurture animals until homes are found. Wessel has also enjoyed travelling through Southern Africa in his trusty bakkie, Spoednik, and plans to venture further afield now that he is unconstrained by leave days and work commitments. Wessel's humble, unassuming, deep thinking and quietly assertive manner have been a hallmark of forestry science in SANParks. His gracious humour, thoughtful wisdom, mentorship for passionate young scientists, and gentle sharing of longer-term context and institutional memory will be sorely missed in the Garden Route. Go well, dear Wessel!


Wessel inspiring the next generation of thinkers, Thabang and Nthabeliseni. © Diba Rikhotso


Wessel relaxing in a fynbos transect © Diba Rikhotso

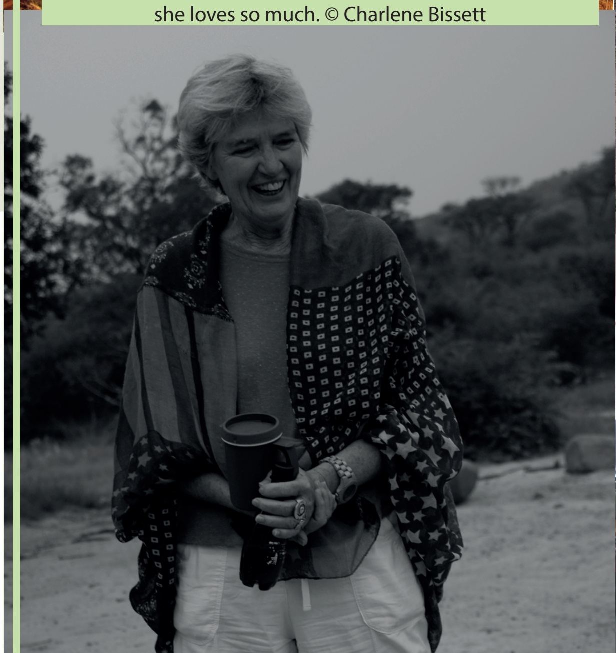
Farewell 'mamma' Wendy

Nicola van Wilgen
and colleagues

Dr Wendy Annecke joined SANParks in 2011 as the Social Scientist for the Cape Region. She brought a wealth of experience, moving from an established career working on topics such as access to energy and resources by people in rural settings. As a social scientist in SANParks, her work included ensuring sustainable access to natural resources and benefits from parks, particularly in Agulhas and the Kalahari. She also took a keen interest in the cultural history of parks, including careful investigative work into the 500 year-old skeleton of a woman recovered from Perdekloof Gorge in Tankwa Karoo National Park. In 2013 she was appointed as general manager of the Cape Research Centre. As a manager, Wendy saw both the importance of strategic research vision and building a strong, happy and motivated research team. Her love of people and careful attention to each individual's needs and strengths saw at least six staff members register for post-graduate studies and the research centre grow into the vibrant and engaging place it is today.

Wendy has a deep love for nature and concern for the environment. During her time at SANParks she served on the Minister's Committee of Inquiry into rhino horn trading feasibility. She will be remembered for her tireless work in this regard, and particularly for persevering in very trying circumstances. While she admitted that her effort had come at considerable personal cost, her dedication served as an amazing example of the impact of a resolute individual. Wendy challenged staff to think very differently about people and conservation and the integral role of people and their wellbeing in better understanding and managing protected areas. She ensured that people and social science were placed firmly, not only on the Cape's research agenda, but also in the everyday consciousness of her colleagues. She leaves a large gap, not only in research expertise, but also in her guidance, mentorship, and the way in which she was always available to all staff. We miss you dearly!

Wendy and partner Don with field assistant Willene Saunderson, in the Kalahari dunes she loves so much. © Charlene Bissett



Wendy always smiling – work or play. © Top: Carly Cowell; Bottom L: Kyle Smith, R: Melodie McGeoch

Angela and Carly are off on new and exciting journeys

Angela Gaylard has a long history with SANParks, going back to her PhD fieldwork days when she was a student based in Shingwedzi. She soon joined Scientific Services on contract as coordinator of research in the north of Kruger National Park. Starting in 2006, Angela was based in the Garden Route as regional ecologist for the frontier parks. In April 2018 it was time for a change and Angela took up a position as Head of Science Support at African Parks Network. In her new capacity she continues to be involved with science-management interaction in parks across Africa.

Carly Cowell, who started with SANParks in 2010 as the regional ecologist for the Cape parks, took up a position as a Senior Science Officer and head of the Scientific Authority for Flora at Kew Gardens in London in 2018. Carly was a font of knowledge on all things botanical, with a key understanding of fynbos ecology and plant identification. As the first regional ecologist in the Cape, she fostered trust between managers and scientists and paved the way for fruitful relationships. She was also the key planner for field trips; from equipment to catering and transport.

We will dearly miss these two, as colleagues and friends, and remain grateful for their inputs over the years. We trust that the skills they learned in SANParks will be put to good use in their new roles and we wish them the very best as they continue to be involved in conservation.

Farewell Angela and Carly - we wish you all the best. © Cathy Greaver

Izak Smit

Stef Freitag-Ronaldson

Nicola van Wilgen

A new Wendy has joined Cape Research Centre as General Manager

Wendy loves wild places; four short words that have led to many adventures such as spending time with yaks in Langtang, Nepal (2011). © Guy Dutson

In January 2019, the Cape Research Centre(CRC) received a new general manager, Dr. Wendy Foden. Wendy has broad experience in conservation and climate change. She led SANBI's Threatened Species Programme before joining the IUCN's Global Species Programme in Cambridge, UK, as leader of their Climate Change Programme. Some of the adventurous highlights of her work there, included being "bundled up in the Arctic to strategise about polar bears, following Ebola drills to work on West African bats, running a coral workshop on a yacht in the mediterranean and trying to discuss Asian rhinos while keeping a straight face over insanely hot Nepalese curry". She also chairs the IUCN Species Survival Commission's Climate Change Specialist Group, an international group of experts who help to translate science into practice and policy.

But home is where Wendy's heart is; she returned in 2013 and joined Stellenbosch University to work on climate change impacts in Africa. One of the most exciting things about her time at SANParks so far, has been participating in park management planning and assessment, and seeing what on-the-ground implementation really involves. Helping SANParks to prepare for climate change, and supporting a strong and happy team of CRC science staff are some of her top priorities.

Joining SANParks' Scientific Services as a Regional Ecologist

Abel Ramoelo joined SANParks in September 2018 after about 15 years of service with the Council of Scientific and Industrial Research (CSIR) where he grew from Junior to Principal Research Scientist: Remote Sensing. He has extensive experience in undertaking remote sensing research for addressing issues related to natural resources, environmental and biodiversity conservation. During his time at CSIR he already worked with SANParks scientists on various projects in the Kruger National Park. He completed a PhD in ecological remote sensing from the University of Twente (The Netherlands) in 2012. Abel is excited to join such a dynamic, multidisciplinary and dedicated team upholding SANParks' mandate. His current role expands beyond research to science – management coordination, which fosters the development of research that directly addresses biodiversity problems on the ground. Beyond SANParks, he is appointed by several Universities as research associate or fellow, and also as an editor for one of international remote sensing journals. Abel looks forward to contributing to the SANParks' research strategy and other relevant initiatives within the organization. Abel is a passionate runner and has completed a number of marathons.

My Road to SANParks - Nkabeng (Bennie) Mzileni

When I was first approached to conduct my doctoral research in Kruger National Park (Kruger) my initial reaction was to decline. In my mind, everyone was doing research in Kruger and there really wasn't much left to discover. That was me being naïve; evidently there was more research to be done and a full-fledged doctorate came of it. In those three years in the field and living in the Kruger I became inculcated into the SANParks culture; I call it a culture because it is more than just an organisation. The staff integration, the friendly faces and the dynamic environment made it appealing as a lifestyle. The quality of research and the experiences stayed with me in subsequent years and somehow SANParks kept featuring in my activities. Little did I know that as a result of my engagement with the SANParks culture I would become part of it. When the opportunity came to become a permanent member, I did not think twice and happily relocated to Kimberley to take up my responsibilities as Regional Ecologist for the Arid Region.

Running is my Culture - Bheki Mapanga

I have been a keen runner ever since I can remember. When I was younger, I noticed people taking part in ultra-marathons such as the Comrades, but I never imagined being part of it. However, this all changed in 2008, when I joined SANParks as a marine field ranger in the Tsitsikamma section of the Garden Route National Park and was introduced to the Otter Trail run, initially as race marshal. The Otter Trail is a five day hiking trail along the beautiful, but rugged, coast between Storms River Mouth and Nature's Valley. Once a year, this magnificent coastline attracts hundreds of trail runners from all over the world to take part in the Otter Trail Run, dubbed "the grail of trail". In addition to "The Otter" being my first organised race, it was also my first marathon and I finished within good time! Since then I've run "The Otter" eight times and in 2018 received an award of recognition from the race organisers. Subsequently I've competed in a number of other trail runs as well as the Comrades and Two Oceans marathons.

The trophy received in 2018 for completing the Otter eight consecutive years in a row. © Anonymous

I consider myself fortunate to have had the opportunity to take part in these nature-based activities and have enjoyed nature's free benefits that SANParks offers to those of us who participate in trail running. In addition to connecting with nature, trail runs have afforded me the opportunity to make friends with people from all walks of life (social), be at peace with myself and with nature (spiritual), and encounter weird and wonderful nature first hand while doing what I love (educational).

A 20 year journey in Kruger

Llewellyn reached a 20-year milestone in 2018, having been appointed as the KNP Alien Biota Manager in September 1998. For 18 months prior to that he had worked as a Nature Conservation Diploma student for the alien plant control section and as a Working for Water assistant in Kruger National Park, which instilled an interest and indeed launched a career in invasion biology. While working at the Alien Biota section he completed his B-Tech and M-Tech degrees, assessing various aspects of the ecology and management of sour prickly pear (*Opuntia stricta*). In 2001, he moved to Scientific Services to take up a role as scientist, developing a research focus in invasion biology. Experience in managing invasions ensured that he remained true to the needs and expectations of managers in planning future research programmes. He completed his PhD at the University of Cape Town under Prof. Dave Richardson in 2007. Invited to join the Centre of Excellence for Invasion Biology at Stellenbosch University initially as a Research Associate, he was made a Core Team Member in 2010. In 2018 he was appointed as Associate Professor Extraordinary at the Department of Botany and Zoology at Stellenbosch University.

Llewellyn Foxcroft's 20-year journey in SANParks - from student to Associate Professor Extraordinary at Stellenbosch University. © Sandra MacFadyen

Three decades of living the dream

1 April 2018 marked a very special day for three of our colleagues who had all started on their journey with SANParks 10 years previously to the day! This milestone was celebrated together with friends and colleagues, under the most beautiful African sky next to a magnificent bonfire on the banks of the Limpopo River in Mapungubwe National Park. Our colleagues had the following reflections on their decade of work with the organisation:

Sam Ferreira, Large Mammal Ecologist
"In ten years I have not slept with a door closed in Skukuza. The twinkle of fireflies and a concocted cacophony of fruit bats, bush babies, owls, hyenas and the odd lion or leopard greet me every night. I love the sounds and privilege of living in Kruger National Park day in and day out! In ten years, I have learned more about people than animals. Even though I studied all the hairy big biting and charging lions, elephants and rhinos, and even a scaly crocodile, I know that saving people by having nature make a difference for how people live is at the heart of having bush around in future for children to enjoy and benefit from. The celebration in the middle of the Limpopo River in Mapungubwe National Park with a moonlit vista of Zimbabwe and Botswana flanked by silhouettes of elephants and hearing people sing along with the rhythms of a village celebrated this key decadal lesson. And at the heart of this is the complimentary SANParks family that expands horizons into the wonderful diversity of being a South African."

Louise Swemmer, Scientist: Social and economic research
"What a privilege to have already spent 10 years doing a job that I can honestly say is my absolute dream. I still can't believe they chose me! On this journey I have learnt just as much about myself as I have about the people I work with both inside and outside of SANParks. People, places, perceptions and priorities all matter and each one of us is driven by our own view of the world that is partly shaped by our past. History matters and so do relationships. Relationships take time, energy, passion and people (not necessarily money) and in terms of collaborations and working together, be it between disciplines, departments or stakeholder groups, relationships have the power to trump institutions and paperwork – and should be nurtured as one of the important building blocks for social relevance, a key requirement for sustainability."

Cathy, Sam and Louise celebrating their respective decades of service on the banks of the Limpopo River in Mapungubwe National Park. © Corli Wigley-Coetsee

Cathy Greaver, Regional Ecologist
"I still have to pinch myself when I realise what I have accomplished in my career since I joined SANParks 10 years ago. I never imagined that I will get paid to sit in a helicopter to count all the animals in some of the most beautiful parks in the country? Whilst working from the air one also gets an opportunity to see places and things in the parks where the general public and even fellow colleagues will probably never ever get a chance to see. Come to think of it, I believe that I hold the record as the first coloured lady to have ever flown in a helicopter counting animals in the entire Kruger National Park without getting air sick I might add, which is quite an accomplishment, ask my colleagues! How about that! My work also entails building and continuously nurturing relationships with colleagues and in particular park management which in turn facilitates a common understanding and the on-going process of strategic adaptive management – and I absolutely love it!".

SANParks is going places academically!

© Stellenbosch University

Mohlamatsane Mokhatla - PHD

On 11 December 2018 a PhD was conferred on Mohlamatsane Mokhatla from Stellenbosch University for the project titled "Evaluating the effects of changing global climate on amphibian functional groups of southern Africa: an ecophysiology modelling approach". The study found that the rate at which species will have to shift their current distribution ranges in order to keep up with predicted rates of climate change by 2080 far exceeds the rate at which they would have shifted in order to keep up with the historic climate (i.e. between the Last Glacial Maximum, ≈ 21 000 years ago and current climate). Two of the three species considered in his study are expected to significantly lose suitable climate space by the turn of the century (2080). Mohlamatsane was supervised by John Measey, and co-supervised by Ben Smit and Dennis Rödder.

© Marna Herbst

Deborah Winterton - MSc

Deborah Winterton was awarded her MSc from Nelson Mandela University for her dissertation entitled "Exploring the influence of management practice on mesopredator and herbivore occupancy and interactions". Her study showed that management practice has a significant effect on the occupancy of mammal species, and that small antelope were more abundant outside of the West Coast National Park on less historically disturbed land. Debbi was supervised by Jan Venter at NMU and co-supervised by Nicola van Wilgen (SANParks).

© Laurence Kruger

Ezekiel Kosa and Alison Kock - Ocean Governance Course

In September 2018, Ezekiel Kosa (marine conservation manager, Table Mountain National Park) and Alison Kock (marine biologist, Scientific Services) participated in a month-long course on ocean governance for Africa presented by the International Ocean Institute-South Africa and South African International Maritime Institute. Five major themes were covered, namely threats and opportunities related to oceans and coasts, the governance framework, governance tools, governance in action and creating a supportive environment for the management of oceans and coasts.

Philip Mhlava - Advanced Certificate

Philip Mhlava, SANParks Scientific Services Research Assistant, successfully completed an Advanced Certificate in Nature Conservation in Trans-frontier Conservation Management with South African Wildlife College(SAWC). As the top achieving South African student in his class of 2018 (achieving two distinctions in his second semester), he has subsequently been invited to attend a Conservation Leadership Pilot Program with SAWC and Erusmus University (Netherlands), as well as an African Biology Field Course with Imperial College London.

This year Philip resumes with his pivotal role in biodiversity training and field logistics with the Organization for Tropical Studies, and has chosen to continue his studies on a part-time basis with a course in Project Management through Business Management Training College (BMT).

Wendy Foden

Reflections on 2018/2019

Curating South Africa's national parks involves a myriad of decisions which must be made on behalf of society, each with costs and benefits. SANParks' researchers construct the knowledge foundation for these decisions. By operating from within the organisation that curates our national parks and by engaging directly with our managers, we have a unique role in South Africa's research portfolio. This report provides an overview of the many activities we've carried out in 2018/19. We hope that it has taken readers on an enjoyable journey through our exciting and varied research landscape, and has shared our team's enthusiasm and passion.

All good journeys begin with exploring the landscapes. South Africa's exceptionally diverse ecosystems provide a stunningly scenic backdrop to activities such as monitoring threatened species, documenting aquatic animals, exploring the underwater world of sharks and fish, restoring drylands and understanding inter-tidal ecosystems. Socioeconomic landscapes span dialogue with rural communities to engaging with stakeholders in parks surrounded by cities, agriculture and mining. The journey takes us through mopane worm harvesting in Kruger, Tsitsikamma's cultural roles and Knysna's catastrophic wildfire. We see ants and fire battling savanna trees and soil seed banks helping rehabilitation in the Tankwa Karoo. New technologies help us track fires from space and follow elusive crocodiles. We wage battle against invasive aliens while seagrasses tackle climate change and urban predators face long-term poison exposure. We peek at the secret lives of sharks and sadly, we report on the last wild elephant of the Knysna Forest.

Much of the team's success results from collaboration and co-learning with scientists, conservation planners, practitioners, policy-makers and the public, both nationally and abroad. These co-travellers help us to achieve our objective of deeply engaged science, including through transdisciplinary research across the socio-natural divide. Leveraging capacity and capital far beyond our reach was possible through our 'outdoor labs', strong technical and logistical support and long-term datasets. Many hundreds of researchers have joined us at SANParks-hosted meetings and conferences, enabling co-learning with members of the public, managers and scientists from across the globe.

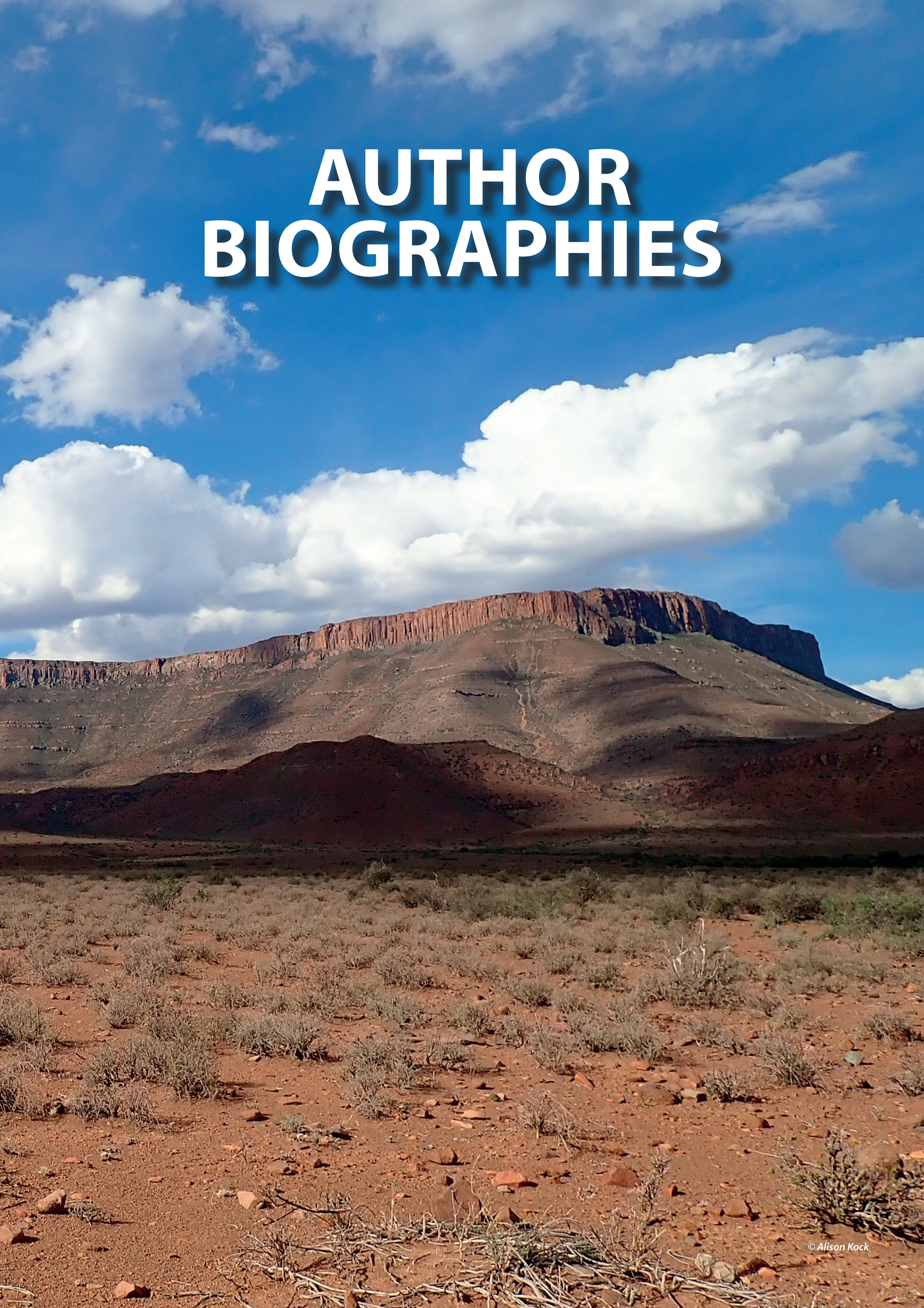
Maps of the journey relied on a well-crafted and thoroughly reviewed research strategy. Meanwhile, the role of embedded research within implementing organisations such as SANParks was evaluated and heralded. A focus on science communication enhanced our knowledge products and our flagship journal, Koedoe, went from strength to strength. We celebrate the team's communication successes, including by listing the wide-ranging and often high-impact papers and conference presentations. Since the driving roles of policy and research are interchangeable, we also focused on contributing to national and international agreements and processes such as the Intergovernmental Platform for Biodiversity and Ecosystem Services, National Biodiversity Assessment and United Nations Convention to Combat Desertification.

The outcomes of great journeys rely on team member's grit, determination, hard work and collaboration; each of these is abundant in SANParks' research team. Members' commitment, hard work and dedication to support both conservation benefits and colleagues are deeply impressive. The multi-decadal careers attest to appreciation of members' inputs and opportunities for development, while notes from new members speak of excitement and enthusiasm.

The continuing trail leads to exciting challenges: supporting newly proclaimed marine protected areas, preparing for climate change, building new partnerships and scanning the conservation horizon for emerging issues. Meeting these challenges lies in the people who use their outstanding skills, knowledge and passion to curate our parks. SANParks' research purpose statement calls for leadership, excellence and impact through credible research and robust dialogue. This report is testimony to the research team's success.

© Alison Kock

AUTHOR BIOGRAPHIES



© Alison Kock

DR ABEL RAMOELA
Abel is a Regional Ecologist for the Northern Region. He likes integrating in-situ and satellite based observations to facilitate decision-making processes pertaining to biodiversity conservation and management.

DR ALISON KOCK
Alison is a marine biologist at the Cape Research Centre and an Honorary Research Associate at the South African Institute of Aquatic Biodiversity and the Institute for Communities and Wildlife in Africa. Her current research focus is on measuring marine protected area effectiveness and determining the role top predators play in shaping marine ecosystems.

AVHAVHUDZANI PHOPHE
Avhavhudzani joined the Cape Research Centre in 2016 as a Junior Scientist. Her interest is in climate change mitigation in national parks, including carbon footprint assessment and carbon storage in ecosystems. She is the first accredited carbon footprint analyst in SANParks. She is currently busy with her MSc at the University of the Western Cape.

BHEKI MAPHANGA
Bheki joined SANParks in 2008 as a field ranger in the Tsitsikamma section of the Garden Route National Park. Currently, he is executing his duties as a bio–technician based at the Rondevlei Office of Scientific Services.

DR CHAD CHENEY
Chad is based at the park planning unit for Table Mountain National Park and has a broad interest in alien species management and conservation planning. Chad recently received his PhD for his work on improving planning and implementation of alien species management within protected areas.

CHENAY SIMMS
Chenay is the GIS Analyst in the Scientific Services Department at Skukuza, where she is responsible for managing the GIS lab and conducting GIS and Remote Sensing projects for KNP and several other parks. After finishing an MSc in Environmental Sciences she worked at the University of South Africa and then at ESRI. However, the lure of the bush proved to be too strong and she accepted her current position in 2013.

CLOVERLEY LAWRENCE
Cloverley recently joined Scientific Services in the Garden Route / Frontier region. Her interests include coastal and marine ecology, with the aim of understanding ecosystem functioning, and recognising the effects of threats and pressures. Her key role is providing sound scientific knowledge to inform how we protect and manage marine protected areas.

DR CORLI WIGLEY–COETSEE
Corli is an ecologist based on the Kruger National Park. She is interested in a wide range of ecological dynamics and management issues associated mostly with plant-herbivore interactions in savannas. She is increasingly aware of the challenges of producing science in a post-truth world where communication is key and has thoroughly enjoyed being part of producing this research report.

DANIE PIENAAR
Danie Pienaar is Head of Scientific Services in SANParks. He enjoys fishing (including for crocodiles), but his real job is to facilitate and enable the research function in SANParks.

DANIËLLE SEYMOUR
Daniëlle is a research intern based in the Garden Route Research Unit. She completed her Honours degree in Geographic Information Systems and Environmental Management in 2017 at the University of the Western Cape.

DR DANNY GOVENDER

Dr Danny Govender is the General Manager for research in the Savanna and Arid Parks. She is a veterinarian and disease ecologist by training, but is especially interested in the changing role of protected areas in the 21st century. She enjoys acting as a bridging agent between science, management and policy making.

DEBORAH WINTERTON

Debbi recently graduated with an MSc from Nelson Mandela University. Her dissertation focused on the effects of management practices on wildlife populations along the West Coast. She is currently putting her skills and knowledge of animal ecology and capture to good use, spending a good amount of time rambling around the wild Table Mountain.

PROF DIRK ROUX

Dirk is a scientist working in the fields of freshwater conservation, ecosystem services and processes of institutional learning and adaptive management. He is also an Adjunct Professor of Nelson Mandela University and a member of their Sustainability Research Unit, where he contributes to supervision of post-graduate students.

GRAHAM DURRHEIM

Graham maintains long-term natural forest dynamics monitoring and research programmes in the Garden Route forests and oversees the development and implementation of the timber harvesting yield regulation system.

DR IAN RUSSELL

Ian conducts research on aquatic ecosystems, and particularly the linkages between biotic changes and ecosystem manipulation and management. Current research focuses mainly on identifying the drivers of spatio-temporal changes in water quality, aquatic plants and waterbird communities in intensively utilised estuaries, and how these are influenced by management actions. He has served on the national Ramsar committee since 2012.

DR IZAK SMIT

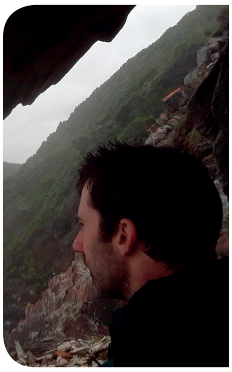
Izak is the System Ecology, GIS and Remote Sensing science manager for the Savanna and Arid Research Unit. He particularly enjoys his job as "translator" in SANParks – translating management concerns into research questions and translating research back into management implications and actions.

JOHAN BAARD

Johan is a scientist responsible for GIS and Vegetation Ecology in the Garden Route National Park. His main focus is on invasive alien plant control planning and research, rehabilitation planning, plant inventories and managing the Geographic Information System of the GRNP. Plant collection to expand species lists is his passion.

JUDITH BOTHA

Judith is the Science Manager responsible for Knowledge Support for the Savanna and Arid Research Unit. She particularly enjoys working with and analysing monitoring data from various disciplines and over extended time frames.



KYLE SMITH

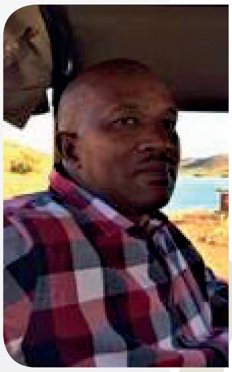
Kyle is a marine ecologist based at Scientific Services in Rondevlei. He is responsible for conducting applied research in the marine and estuarine environments with a particular focus on recreational and subsistence fisheries. Kyle enjoys a challenge and is happiest when in, on, near or under water.

LIZETTE MOOLMAN-VAN DER VYVER

Lizette is a Wildlife Ecologist in the Frontier Region, based at Scientific Services in Rondevlei. Her special interests and research include elephant ecology and management and using camera trap technology for mammal surveys and to investigate the human-wildlife interface.

PROF LLEWELLYN FOXCROFT
Llewellyn has a broad interest in the ecology of invasive species, focusing largely on alien plant invasions and investigating the processes, patterns and impacts of invasion and the links to management interventions. He is Editor-in-Chief of Koedoe.

LOUISE SWEMMER
Louise coordinates a range of people-related research projects falling under social and economic science related fields. She is primarily interested in supporting more effective and fair access to and sharing of benefits flowing from cultural and natural resources within protected areas, in so doing building social relevance for the long term sustainability of conservation and society.



DR LUTHANDO DZIBA
Dr Luthando Dziba is the Managing Executive for the Conservation Services Division in SANParks. Past research involved plant-herbivore interactions, land-use change, woody plant encroachment and how alien invasive plants influence biodiversity and ecosystem services. He has extensive experience in the field of ecosystem services where he managed three research groups at the CSIR before starting at SANParks. He has a strong interest in mainstreaming science into development planning and policy.

DR MARNA HERBST
Marna has a wide interest in the conservation field, from studies on small mammals and carnivores to the connections people experience in nature and the role protected areas can play in the well-being of people. This has led her to expand her research into recreational activities and the interactions between people and nature. Currently Marna is the Regional Ecologist for the Cape Parks.

MEGAN TAPLIN
Megan joined SANParks in 2002, proudly serving as an Environmental Control Officer, Social Ecologist, Communications Manager and Park Manager in Addo Elephant, Mountain Zebra and Garden Route National Parks. Megan is passionate about conserving our country's rich biodiversity heritage and spreading the good news about the benefits of conservation.

MELANIE DE MORNEY
Melanie is a biotechnician in Garden Route National Park. She assists with the implementation of terrestrial fauna-related monitoring and research, especially invertebrate research. She is passionate about biodiversity conservation and environmental education, and has a particular interest in myrmecology.

DR MMOTO MASUBELELE
Mmoto is a Scientist (Landscape Ecology) based at the Cape Research Centre. His landscape work focuses on rehabilitation in arid parks. He also leads the implementation of climate change adaptation and mitigation projects in national parks and represents SANParks on various National Technical Working Groups on Climate Change Adaptation, Ecosystem-based Adaptation and Land Degradation.

DR MOHLAMATSANE MOKHATLA
Mohlamatsane joined SANParks in 2016. In addition to his current role as a social scientist at SANParks, he has a keen interest in other conservation related topics including but not limited to the conservation of African amphibians and the impacts of land-use and climate change on this most threatened vertebrate group.

NANDI MGWADLAMBA
Nandi is the Regional Communications manager for the Garden Route National Parks managing communications for three Parks- Wilderness, Knysna and Tsitsikamma. Nandi has over 18 years of experience in the communications field and has worked for the Department of Water Affairs and Forestry, the South African National Biodiversity Institute's Grasslands Programme.

NDIVIWE BALIWE
Ndiviwe is a marine biotechnician based at the Cape Research Centre. He has a BSc in Zoology at the Walter Sisulu University and is completing an MSc on the effects of harvesting on intertidal rocky shores in Table Mountain National Park, at the University of Cape Town.

NELSIWE MPAPANE
Nelsiwe is a SANParks junior scientist and Masters degree candidate at Nelson Mandela University, George campus. Her research explores the delivery of cultural ecosystem services in Mountain Zebra National Park and neighboring Mountain Zebra-Camdeboo protected environment. Her greatest life passion lies in exploring the intrinsic values of nature and re-awakening humans' sense of being one with the natural environment.

NERINA KRUGER
Nerina is a Science Liaison and GIS officer at Rondevlei Scientific Services. Her main function is to oversee research project administration and supply logistical support to researchers working in the Garden Route and Frontier parks. Some other functions include GIS analysis of monitoring data, database management and the development of Cybertracker sequences.

DR NICOLA VAN WILGEN
Nicola is based at the Cape Research Centre and has a general interest in global change, knowledge management, data analysis and integrated management of conservation areas to ensure a sustainable future.

DR NKABENG (BENNIE) MZILENI
Nkabeng is the Regional Ecologist of the Arid Parks which include Mokala, Kalahari, Augrabies, Richtersveld and soon SKA. Nkabeng studied behavioural ecology of large predators but is not limited to mammals. She is passionate about exploring the African wilderness in all its complexities. Happiest moments are spent in the field with coffee, rusks and sounds of the bush.

PAULI VILJOEN
Pauli is employed by Scientific Services as Large Vertebrate Research Logistics Coordinator. I have the privilege to work in several parks on large animals trying my best to make research operations run smoothly. I particularly enjoy working on projects that have a direct influence on conservation management.

PETER GORDON
Peter (Paddy) has been working for SANParks for the past 30 years. He started as an educational officer, but soon switched over to Park Management. He has managed the Richtersveld, Mountain Zebra, Table Mountain and Garden Route National Parks as part of his career, filled with a variety of rich experiences.

ROBIN PETERSEN
Robin is the Freshwater Ecologist: Scientific Services, Kruger National Park. His research interests include integrated bio-monitoring of freshwater ecosystems and understanding cues and the effects of barriers to the natural migration of various fish species.

ROXANNE ERUSAN
Roxanne is the biotechnician for Mountain Zebra, Camdeboo, Karoo and Addo Elephant National Parks including the MPA. The diversity across the different parks for which she is responsible makes her involved in various monitoring tasks including mammals, freshwater, marine, vegetation, and spatial collar data as well as managing a research facility in Addo.

RUTH-MARY FISHER
Ruth-Mary is the Earth System Scientist also working in freshwater ecology for the CRC. Her biggest research project is on fire and soil hydrophobicity in fynbos ecosystems. She is hoping to complete her PhD on this topic by December 2019, while also managing the Freshwater Monitoring Programme for the Cape Parks.

DR SAM FERREIRA
Sam is a large mammal ecologist. Sam advocates that the saving of rhinos depends on saving people of injustice. In his spare time he counts lions, watches a few elephants, and works out which game species can be caught where and taken somewhere else.

SAMANTHA MABUZA
Samantha is the Science Liaison Officer for the Savanna and Arid Research Node. Her current interests include science communication and how to use social media to share science with the public.

DR SANDRA TALJAARD
Sandra is the Park Manager of Wilderness National Park within the Garden Route where she manages the integrated nature of the complex people-environment interface of conservation, tourism and social ecological systems. Being in SANParks for 29 years she also worked in the Cape, Arid and Northern Regions and has a particular interest in Environmental Education and Stakeholder Engagement.

SISANDA MAYEKISO
Sisanda is a Junior Marine Scientist based at Cape Research Centre. She obtained an MSc in ichthyology from Rhodes University. She is currently focusing on understanding changes in the number and diversity of fish over time using Baited Remote Underwater Video (BRUV) technology within marine protected areas.

STEPHEN MIDZI
Stephen Midzi is the Manager: Biodiversity and Conservation within Kruger. He has worked in SANParks since 2006, previously as Section Ranger before joining Conservation Management where he enjoys the challenges of problem animal management, amongst others. He is an artist at heart, and relaxes through painting, and playing guitar and saxophone.

DR STEF FREITAG-RONALDSON
Stef heads up the Garden Route and Frontier Research Unit where she enjoys working and learning at the intersection of science, decision-making, policy and science communication. She sees her leadership role as helping to bridge across disciplines, science and management, and to diverse stakeholder groups.

TERCIA STRYDOM
Tercia is the Abiotic Scientist based in Kruger National Park. Her research interests are soil hydrology, fire ecology and geohydrology. She's been working for SANParks 7 years, she completed her MSc in Hydrology with the University of KwaZulu-Natal.

THEMBEKA TWALA
Thembeka is an assistant cluster manager for biodiversity social projects within KNP based at Skukuza Scientific Services. She is working on alien invasive species with special interest and a research project on *Parthenium hysterophorus*.

TREVOR ADAMS
Trevor is a Terrestrial Biotechnician at the Cape Research Centre and provides scientific services for the Cape Cluster Parks and Namaqua National Park. He is responsible for plant species of special concern monitoring programmes. He also provides a supportive role to the freshwater monitoring programme and NFEPA wetland ground truthing in Agulhas National Park and is SASS5 accredited.

DR WENDY FODEN
Wendy is the General Manager at the Cape Research Centre and Chair of the IUCN Species Survival Commission's Climate Change Specialist Group. Wendy loves wild places and has worked all over the world. She is putting her experience into practice to focus research strategy and guide SANParks in preparing for climate change.

ZISHAN EBRAHIM
Zishan is an ecological geographer and GIS technician at the Cape Research Centre. He is involved with animal species of special concern monitoring, particularly amphibians and their freshwater habitats. He completed his MSc in Zoology in 2017 at Stellenbosch University's Centre for Invasion Biology, focusing on the spatial distribution of threats to amphibians of the Cape Peninsula.

APPENDICES

Appendix A: Papers published based on research conducted in SANParks per park

SANParks authors in bold

Addo Elephant National Park

Baotic, A., Garcia, M., Boeckle, M. and Stoeger, A., 2018. Field Propagation Experiments of Male African Savanna Elephant Rumbles: A Focus on the Transmission of Formant Frequencies. Animals, 8(10), p.167.

Comley, J., **Bissett, C.**, Tambling, C.J., Welch, R.J. and Parker, D.M., 2018. Diet of recently established brown hyaenas in the Eastern Cape, South Africa. African Journal of Wildlife Research, 48(1), pp.1-7.

Kerley, G.I., Landman, M., Ficetola, G.F., Boyer, F., Bonin, A., Rioux, D., Taberlet, P. and Coissac, E., 2018. Diet shifts by adult flightless dung beetles Circellium bacchus, revealed using DNA metabarcoding, reflect complex life histories. Oecologia, 188(1), pp.107-115.

Landman, M., Kloppers, K. and Kerley, G.I., 2018. Settling the browser-grazer debate for African buffalo in grass-limited Eastern Cape thicket, South Africa. Koedoe, 60(1), pp.1-4.

Landman, M., Mgqatsa, N., Cromsigt, J.P. and Kerley, G.I., 2019. Elephant effects on treefall and logfall highlight the absence of megaherbivores in coarse woody debris conceptual frameworks. Forest Ecology and Management, 438, pp.57-62.

Camdeboo National Park

Lea, J.M., Walker, S.L., Kerley, G.I., Jackson, J., Matevich, S.C. and Shultz, S., 2018. Non-invasive physiological markers demonstrate link between habitat quality, adult sex ratio and poor population growth rate in a vulnerable species, the Cape mountain zebra. Functional Ecology, 32(2), pp.300-312.

Mills, A.J., Milton, S.J., Taplin, B.D. and Allen, J.L., 2018. Viability of watering Portulacaria afra truncheons to facilitate restoration of subtropical thicket: Results from a nursery experiment and cost model. South African Journal of Botany, 115, pp.58-64.

Garden Route National Park

Baard, J.A. and Kraaij, T., 2019. Use of a rapid roadside survey to detect potentially invasive plant species along the Garden Route, South Africa. Koedoe, 61(1), p.10.

Goets, S.A., Kraaij, T. and Little, K.M., 2018. Seed bank and growth comparisons of native (Virgilia divaricata) and invasive alien (Acacia mearnsiiand A. melanoxylon) plants: implications for conservation. PeerJ, 6, p.e5466.

Kraaij, T., **Baard, J.A.**, Arndt, J., Vhengani, L. and **van Wilgen, B.W.**, 2018. An assessment of climate, weather, and fuel factors influencing a large, destructive wildfire in the Knysna region, South Africa. Fire Ecology, 14(2), p.4.

Lee, D.H., Roux, J., Wingfield, B.D. and Wingfield, M.J., 2018. Non-Mendelian segregation influences the infection biology and genetic structure of the African tree pathogen Ceratocystis albifundus. Fungal biology, 122(4), pp.222-230.

Luyt, J., Hare, V.J. and Sealy, J., 2019. The relationship of ungulate $_{\delta 13C}$ and environment in the temperate biome of southern Africa, and its palaeoclimatic application. Palaeogeography, palaeoclimatology, palaeoecology, 514, pp.282-291.

Mathevet, R., Allouche, A., Nicolas, L., Mitroi, V., Fabricius, C., Guerbois, C. and Anderies, J., 2018. A Conceptual Framework for Heuristic Progress in Exploring Management Regime Shifts in Biodiversity Conservation and Climate Change Adaptation of Coastal Areas. Sustainability, 10(11), p.4171.

Moolman, l., **De morney, M.A.**, **Ferreira, S.M.**, Ganswindt, A., Poole, J.H. and Kerley, G.L., 2019. And then there was one: a camera trap survey of the declining population of African elephants in Knysna, South Africa. African Journal of Wildlife Research, 49(1), pp.16-26.

Moolman, L., **Ferreira, S.M.**, Gaylard, A., **Zimmerman, D.** and Kerley, G.I.H. (2019). The decline of the Knysna elephants: Pattern and hypotheses. South African Journal of Science, 115(3/4), Art. #4805, 7 pages. https://doi.org/10.17159/ sajs.2019/4805

Pollard, M., Whitfield, A.K. and Hodgson, A.N., 2018. Possible influences of a macroalgal bloom in eelgrass beds on fish assemblages in the lower Knysna Estuary, South Africa. African Journal of Aquatic Science, 43(3), pp.319-323.

Smith, M.K., Rodrigues, D. and Currie, B., 2018. A survey of the ichthyofauna in the Noetsie Estuary, Western Cape Province, South Africa. Koedoe, 60(1), pp.1-7.

Verschuuren, B. and Brown, S., 2018. Reflections on the situational and relational contexts of cultural and spiritual significance of nature in protected and conserved areas. Cultural and Spiritual Significance of Nature in Protected Areas: Governance, Management and Policy.

Golden Gate Highlands National Park

Momberg, M., Greve, M., van der Merwe, S. and le Roux, P.C., 2018. Fine-and broad-scale distribution of a cushion plant species: Patterns and predictors for Euphorbia clavarioides. Arctic, Antarctic, and Alpine Research, 50(1), p.e1505136.

Kgalagadi Transfrontier Park

Adams, R. and Kwiecinski, G., 2018. Sonar Surveys for Bat Species Richness and Activity in the Southern Kalahari Desert, Kgalagadi Transfrontier Park, South Africa. Diversity, 10(3), p.103.

Karoo National Park

Codron, D., Radloff, F.G., Codron, J., Kerley, G.I. and Tambling, C.J., 2018. Meso-carnivore niche expansion in response to an apex predator's reintroduction–a stable isotope approach. African Journal of Wildlife Research, 48(1), pp.1-16.

Sloggett, J.J., 2018. Field observations of putative bone-based fluorescence in a gecko. Current Zoology, 64(3), pp.319-320.

Kruger National Park

Basson, L., Hassim, A., Dekker, A., Gilbert, A., Beyer, W., Rossouw, J. and Van Heerden, H., 2018. Blowflies as vectors of Bacillus anthracis in the Kruger National Park. Koedoe, 60(1), pp.1-6.

Bertschinger, H.J., Delsink, A., Van Altena, J.J. and Kirkpatrick, J.F., 2018. Porcine zona pellucida vaccine immunocontraception of African elephant (Loxodonta africana) cows: A review of 22 years of research. Bothalia-African Biodiversity & Conservation, 48(2), pp.1-8.

Burnett, M.J., O'Brien, G.C., Wepener, V. and **Pienaar, D.**, 2018. The spatial ecology of adult Labeobarbus marequensis and their response to flow and habitat variability in the Crocodile River, Kruger National Park. African Journal of Aquatic Science, pp.1-10.

Buscher, B., 2018. From biopower to ontopower? Violent responses to wildlife crime and the new geographies of conservation. Conservation and Society, 16(2), p.157.

Cook, R.M. and Henley, M.D., 2019. Complexities associated with elephant impact on Sclerocarya birrea subsp. caffra in the Greater Kruger National Park. South African Journal of Botany, 121, pp.543-548.

Cornel, A.J., Lee, Y., Almeida, A.P.G., Johnson, T., Mouatcho, J., Venter, M., De Jager, C. and Braack, L., 2018. Mosquito community composition in South Africa and some neighboring countries. Parasites & Vectors, 11(1), p.331.

Davies, A.B. and Asner, G.P., 2019. Elephants limit aboveground carbon gains in African savannas. Global Change Biology, 25(4), pp. 1368-1382.
de Swardt, D.B., **Wigley-Coetsee, C.** and O'Connor, T.G., 2018. Insect outbreaks alter nutrient dynamics in a southern African savanna: patchy defoliation of Colophospermum mopane savanna by Imbrasia belina larvae. Biotropica, 50(5), pp.789-796.

Deacon, F. and Tutchings, A., 2019. The South African giraffe Giraffa camelopardalis giraffa: a conservation success story. Oryx, 53(1), pp.45-48.

Eze, P.N. and Knight, J., 2018. A geomorphological characterisation of river systems in South Africa: A case study of the Sabie River. Physics and Chemistry of the Earth, Parts A/B/C, 105, pp.196-205.

Ferreira, J.G., 2018. Student Perceptions of a Place-Based Outdoor Environmental Education Initiative: A Case Study of the "Kids in Parks" Program. Applied Environmental Education & Communication, pp.1-10.

Ferreira, S.M., **le Roex, N.** and **Greaver, C.**, 2019. Species-specific drought impacts on black and white rhinoceroses. PloS one, 14(1), p.e0209678.

Garba, D.L., Garba, S.M., Gumel, A.B. and Sharomi, O., 2018. Mathematics of FIV and BTB dynamics in buffalo and lion populations at Kruger National Park. Mathematical Methods in the Applied Sciences, 41(18), pp.8697-8723.

Gokool, S., **Riddell, E.S.**, Swemmer, A., Nippert, J.B., Raubenheimer, R. and Chetty, K.T., 2018. Estimating groundwater contribution to transpiration using satellite-derived evapotranspiration estimates coupled with stable isotope analysis. Journal of Arid Environments, 152, pp.45-54.

Herbig, F. and Minnaar, A., 2018. Pachyderm poaching in Africa: interpreting emerging trends and transitions. Crime, Law and Social Change, pp.1-16.

Heritage, G., Entwistle, N., Milan, D. and Tooth, S., 2019. Quantifying and contextualising cyclone-driven, extreme flood magnitudes in bedrock-influenced dryland rivers. Advances in Water Resources, 123, pp.145-159.

Hooijberg, E.H., Miller, M., Cray, C., **Buss, P.**, Steenkamp, G. and Goddard, A., 2018. Serum protein electrophoresis in healthy and injured southern white rhinoceros (Ceratotherium simum simum). PloS one, 13(7), p.e0200347.

Hooten, M.B., Scharf, H.R. and Morales, J.M., 2019. Running on empty: recharge dynamics from animal movement data. Ecology letters, 22(2), pp.377-389.

Jooste, J. and **Ferreira, S.M.**, 2018. An appraisal of green militarization to Protect Rhinoceroses in Kruger National Park. African Studies Quarterly, 18(1), pp.49-59.

Kerr, T.J., Matthee, S., **Govender, D.**, Tromp, G., Engelbrecht, S. And Matthee, C.A., 2018. Viruses as indicators of contemporary host dispersal and phylogeography: an example of feline immunodeficiency virus (fivp le) in free-ranging African lion (Panthera leo). Journal of Evolutionary biology, 31(10), pp.1529-1543.

Knight, J. and Evans, M., 2018. Luminescence dating, sediment analysis, and flood dynamics on the Sabie River, South Africa. Geomorphology, 319, pp.1-14.

Lubbe, B.A., Du Preez, E.A., Douglas, A. and Fairer-Wessels, F., 2019. The impact of rhino poaching on tourist experiences and future visitation to National Parks in South Africa. Current Issues in Tourism, 22(1), pp.8-15.

MacFadyen, S., Hui, C., Verburg, P.H. and Van Teeffelen, A.J., 2019. Spatiotemporal distribution dynamics of elephants in response to density, rainfall, rivers and fire in Kruger National Park, South Africa. Diversity and Distributions, 25(6), pp. 880-894.

Messina, M., Cunliffe, R., Farcomeni, A., Malatesta, L., **Smit, I.P.J**, Testolin, R., Ribeiro, N.S., Nhancale, B., Vitale, M. and Attorre, F., 2018. An innovative approach to disentangling the effect of management and environment on tree cover and density of protected areas in African savanna. Forest Ecology and Management, 419, pp.1-9.

Milan, D.J., Heritage, G., Entwistle, N.S. and Tooth, S., 2018. Morphodynamic simulation of sediment deposition patterns on a recently stripped bedrock anastomosed channel. Proceedings of the International Association of Hydrological Sciences (PIAHS), 377, pp.51-56.

Miller, M.A., **Buss, P.**, Roos, E.O., **Hausler, G.**, Dippenaar, A., Mitchell, E., van Schalkwyk, L., Robbe-Austerman, S., Waters, W.R., Sikar-Gang, A. and Lyashchenko, K.P., 2019. Fatal Tuberculosis in a Free-Ranging African Elephant and One Health Implications of Human Pathogens in Wildlife. Frontiers in Veterinary Science, 6.

Mouatcho, J., Cornel, A.J., Dahan-Moss, Y., Koekemoer, L.L., Coetzee, M. and Braack, L., 2018. Detection of Anopheles rivulorum-like, a member of the Anopheles funestus group, in South Africa. Malaria Journal, 17(1), p.195.

Munyati, C., 2018. Optimising multiresolution segmentation: delineating savannah vegetation boundaries in the Kruger National Park, South Africa, using Sentinel 2 MSI imagery. International Journal of Remote Sensing, 39(18), pp.5997-6019.

Munyati, C., 2019. Comparative performance of regression tree and parametric classification of savannah woody cover on SPOT 6 NAOMI imagery. Remote Sensing Applications: Society and Environment, 13, pp.171-182.

Murn, C. and Botha, A., 2018. A clear and present danger: impacts of poisoning on a vulture population and the effect of poison response activities. Oryx, 52(3), pp.552-558.

Ndlovu, M., Pérez-Rodríguez, A., Devereux, E., Thomas, M., Colina, A. and Molaba, L., 2018. Water for African elephants (Loxodonta africana): faecal microbial loads affect use of artificial waterholes. Biology Letters, 14(8), p.20180360.

O'Brien, G.C., Burnett, M. & **Petersen, R.** 2018. Rivers of the Kruger National Park in a sea of dams. In: From Sea to Source 2.0: Protection and restoration of fish migration in rivers worldwide (eds: Brink, K., Gough, P., Royte, J., Schollerman, P.P and Wanningen, H.), pp 38-39.

O'Brien, G.C., Burnett, M. & **Petersen, R.** 2018. Tiger fish of (Hydrocynus vittatus) of the Sabie River. In: From Sea to Source 2.0: Protection and restoration of fish migration in rivers worldwide (eds: Brink, K., Gough, P., Royte, J., Schollerman, P.P and Wanningen, H.), pp 308-309

Page-Nicholson, S.K., Tate, G., Hoogstad, C., Murison, M., Diamond, M., Blofield, A., Pretorius, M. and Michael, M.D., 2018. Mitigating the impact of large mammals on wooden electrical distribution poles in the Kruger National Park, South Africa. African Journal of Wildlife Research, 48(2).

Pretorius, Y., Garaï, M.E. and Bates, L.A., 2018. The status of African elephant Loxodonta africana populations in South Africa. Oryx, pp.1-7.

Reinwarth, B., **Petersen, R.** and Baade, J., 2019. Inferring mean rates of sediment yield and catchment erosion from reservoir siltation in the Kruger National Park, South Africa: An uncertainty assessment. Geomorphology, 324, pp.1-13.

Roos, E.O., Olea-Popelka, F., **Buss, P.**, de Klerk-Lorist, L.M., Cooper, D., van Helden, P.D., Parsons, S.D.C. and Miller, M.A., 2018. Seroprevalence of Mycobacterium bovisinfection in warthogs (Phacochoerus africanus) in bovine tuberculosis-endemic regions of South Africa. Transboundary and Emerging Diseases, 65(5), pp.1182-1189.

Singh, J., Levick, S.R., Guderle, M., Schmullius, C. and Trumbore, S.E., 2018. Variability in fire-induced change to vegetation physiognomy and biomass in semi-arid savanna. Ecosphere, 9(12), p.e02514.

Sköld, M. and Knape, J., 2018. Bounding reproductive rates in state-space models for animal population dynamics. Ecosphere, 9(5), p.e02215.

Smit, I.P.J. and Archibald, S., 2019. Herbivore culling influences spatio-temporal patterns of fire in a semiarid savanna. Journal of Applied Ecology, 56(3), pp.711-721.

Sutherland, K., Ndlovu, M. and Pérez-Rodríguez, A., 2018. Use of artificial waterholes by animals in the southern region of the Kruger National Park, South Africa. African Journal of Wildlife Research, 48(2).

Swemmer, A.M., Bond, W.J., Donaldson, J., Hempson, G.P., Malherbe, J. and **Smit, I.P.J.**, 2018. The ecology of drought-a workshop report. South African Journal of Science, 114(9-10), pp.1-3.

Taiti, S., 2018. A new termitophilous species of Armadillidae from South Africa (Isopoda: Oniscidea). Onychium, 14: 9-15

Tavalire, H.F., Beechler, B.R., **Buss, P.E.**, Gorsich, E.E., Hoal, E.G., **le Roex, N.**, Spaan, J.M., Spaan, R.S., van Helden, P.D., Ezenwa, V.O. and Jolles, A.E., 2018. Context-dependent costs and benefits of tuberculosis resistance traits in a wild mammalian host. Ecology and evolution, 8(24), pp.12712-12726.

Thaker, M., Gupte, P.R., Prins, H.H.T., Slotow, R. and Vanak, A.T., 2019. Fine-scale tracking of ambient temperature and movement reveals shuttling behaviour of elephants to water. Frontiers in Ecology and Evolution, 7, p.4.

Underhill, L., Loftie-Eaton, M. and Navarro, R., 2018. Odonata of the Kruger National Park. Biodiversity Observations, 9, pp.9-11.

Urban, M., Berger, C., Mudau, T., Heckel, K., Truckenbrodt, J., Onyango Odipo, V., **Smit, I.P.J.** and Schmullius, C., 2018. Surface Moisture and Vegetation Cover Analysis for Drought Monitoring in the Southern Kruger National Park Using Sentinel-1, Sentinel-2, and Landsat-8. Remote Sensing, 10(9), p.1482.

Van Hooft, P., Keet, D.F., Brebner, D.K. and Bastos, A.D., 2018. Genetic insights into dispersal distance and disperser fitness of African lions (Panthera leo) from the latitudinal extremes of the Kruger National Park, South Africa. BMC genetics, 19(1), p.21.

Van Coller, H., Siebert, F., Scogings, P.F. and Ellis, S., 2018. Herbaceous responses to herbivory, fire and rainfall variability differ between grasses and forbs. South African Journal of Botany, 119, pp.94-103.

Mapungubwe National Park

Collinson, W.J., Marneweck, C. and Davies-Mostert, H.T., 2018. Protecting the protected: reducing wildlife roadkill in protected areas. Animal Conservation.

Parker, D.M. and Bernard, R.T., 2019. The use of acoustic detectors for assessing bat species richness and functional activity in a South African National Park. Mammalia, 83(1), pp.53-63.

Sinthumule, N.I., 2018. Stakeholder perspectives on tourism development in the Greater Mapungubwe Transfrontier. African Journal of Hospitality, Tourism and Leisure, Volume 7 (5) - (2018) ISSN: 2223-814X Copyright: © 2018 AJHTL /Author/s- Open Access- Online @ http//: www.ajhtl.com

Snyman, A., Raynor, E., Chizinski, C., Powell, L. and Carroll, J., 2018. African lion (panthera leo) space use in the greater mapungubwe transfrontier conservation area. African Journal of Wildlife research, 48(2), pp.1-12.

Teren, G., Owen-Smith, N. and Erasmus, B.F.N., 2018. Elephant-mediated compositional changes in riparian canopy trees over more than two decades in northern Botswana. Journal of Vegetation Science, 29(4), pp.585-595.

Mokala National Park

Coetzee, H. and Nell, W., 2019. The feasibility of national parks in South Africa endorsing a community development agenda: The case of Mokala National Park and two neighbouring rural communities. Koedoe: African Protected Area Conservation and Science, 61(1), pp.1-13.

Mountain Zebra National Park

Brown, L.R. and **Bezuidenhout, H.**, 2018. Ecosystem description and diversity of the Jurisdam–Seekoegat sections of the Mountain Zebra National Park, South Africa. South African Journal of Botany, 118, pp.166-178.

Horwitz, L.K., **Bissett, C.** and Brink, J., 2018. Recent cheetah (Acinonyx jubatus) kills as carnivore “feeding hubs”: a taphonomic study of prey size and age differences. Quaternaire. Revue de l’Association française pour l’étude du Quaternaire, 29(1), pp.5-12.

Multiple National Parks

Ackers, B., 2018. Accounting for rhinos–the case of South African National Parks (SANParks). Social Responsibility Journal, 15(2), pp. 186-207.

Cheney, C., Esler, K.J., **Foxcroft, L.C.**, **van Wilgen, N.J.** and McGeoch, M.A., 2018. The impact of data precision on the effectiveness of alien plant control programmes: a case study from a protected area. Biological Invasions, 20(11), pp.3227-3243.

Foxcroft, L.C., Spear, D., **van Wilgen, N.J.** and McGeoch, M.A., 2019. Assessing the association between pathways of alien plant invaders and their impacts in protected areas. NeoBiota, 43, p.1.

Khumalo, Z.T., Brayton, K.A., Collins, N.E., Chaisi, M.E., Quan, M. and Oosthuizen, M.C., 2018. Evidence confirming the phylogenetic position of Anaplasma centraleex (Theiler 1911) Ristic and Kreier 1984. International journal of systematic and evolutionary microbiology, 68, pp. 2682-2691.

Kruger, M., Van der Merwe, P., Bosch, Z.J. and Saayman, M., 2018. Adventure activity preferences in South African national parks. South African Journal for Research in Sport, Physical Education and Recreation, 40(1), pp.1-23.

le Roex, N., Paxton, M., **Adendorff, J.**, **Ferreira, S.** and O’Riain, M.J., 2018. Starting small: long-term consequences in a managed large-mammal population. Journal of Zoology, 306(2), pp.95-100.

Minnie, L., Zalewski, A., Zalewska, H. and Kerley, G.I., 2018. Spatial variation in anthropogenic mortality induces a source–sink system in a hunted mesopredator. Oecologia, 186(4), pp.939-951.

Morrison-Saunders, A., Hughes, M., Pope, J., Douglas, A. and **Wessels, J.A.**, 2019. Understanding visitor expectations for responsible tourism in an iconic national park: differences between local and international visitors. Journal of Ecotourism, pp.1-11.

Patrut, A., Woodborne, S., Patrut, R.T., Rakosy, L., Lowy, D.A., Hall, G. and Karl, F., 2018. The demise of the largest and oldest African baobabs. Nature Plants, 4(7), p.423.

Pierce, S.J., Holmberg, J., Kock, A.A. & Marshall, A.D. 2018. Photographic Identification of Sharks. In: Shark Research: Emerging Technologies and Applications for the Field and Laboratory (eds Carrier JC, Heithaus MR, Simpfendorfer CA). CRC Press, 392 pages.

Vermeulen, W.J, **Van Wilgen, N.**, **Smith, K.**, **Depolo, M.**, **Swemmer, L.**, **Annecke, W.**, **Bezuidenhout, H.**, **Durrheim, G.**, **Hanekom, N.**, **Hendricks, H.**, McGeoch, M., **Ngubeni, N.**, and **Symonds, A.,** Monitoring consumptive resource use in South African national parks. Koedoe [online]. 2019, vol.61, n.1 http://dx.doi.org/10.4102/koedoe.v61i1.1516

Wigley, B.J., Fritz, H. and Coetsee, C., 2018. Defence strategies in African savanna trees. Oecologia, 187(3), pp.797-809.

Namaqua National Park

Kovtunovich, V.N. and Ustjuzhanin, P.Y., 2018. Pterophoridae of the South Africa National Park Namaqua (Lepidoptera: Pterophoridae). SHILAP Revista de Lepidopterologia, 46(184).

Pieterse, Z., Aveling, T.A., Jacobs, A. and Cowan, D.A., 2018. Seasonal variability in fungal endophytes from Aizoaceae plants in the Succulent Karoo biodiversity hotspot, South Africa. Journal of arid environments, 156, pp.19-26.

Other

Buss, P. and Miller, M. 2018. Update on field anesthesia protocols for free-ranging African lions. In, Miller, R.E., Lamberski, N. & Calle, P.P. (eds.), Zoo and Wildlife Animal Medicine, Current Therapy 9th Ed., Esevier, St. Louis, Missouri., pp. 536-538

Bezuidenhout, H., Botha, J., Ramaswiela, T. & O'Connor, T. 2018. Karakteristieke van langtermyn saamgestelde variasie van die kruidstratum in 'n semi-ariede Afrika savanna: Reënval, grondtipe enplantspesies funksionele groepe, Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie 37(1): 1-15pp.

Boesch, J.M., Gleed, R.D., **Buss, P.**, **Hofmeyr, M.**, Tordiffe, A., Zeiler, G. and Meyer, L., 2018. Effects of a supplemental etorphine dose on pulmonary artery pressure and cardiac output in immobilized, boma-habituated white rhinoceros (Ceratotherium simum): a preliminary study. Journal of Zoo and Wildlife Medicine, 49(4), pp.849-855.

Cheney, C., Esler, K.J., **Foxcroft, L.C.** and **van Wilgen, N.J.**, 2019. Scenarios for the management of invasive Acacia species in a protected area: Implications of clearing efficacy. Journal of environmental management, 238, pp.274-282.

Codron, J., Avenant, N.L., **Wigley-Coetsee, C.** and Codron, D., 2018. Carnivore stable carbon isotope niches reflect predator–prey size relationships in African savannas. Integrative zoology, 13(2), pp.166-179.

De Vos, A., Joana, C.B. and **Roux, D.**, 2018. Relational values about nature in protected area research. Current opinion in environmental sustainability, 35, pp. 89-99..

Dudley, N., Hockings, M., Stolton, S., Amend, T., Badola, R., Bianco, M., Chettri, N., Cook, C., Day, J.C., Dearden, P. , **Roux D** and Edwards, M., 2018. Priorities for protected area research. Parks, 24(1), pp.35-50.

Gillson, L., Biggs, H., **Smit, I.P.J.**, Virah-Sawmy, M. and Rogers, K., 2018. Finding Common Ground between Adaptive Management and Evidence-Based Approaches to Biodiversity Conservation. Trends in ecology & evolution, 34(1), pp. 31-44.

Glenn, I., Ferreira SM, Pienaar D., 2019. Communication on rhino poaching: Precautionary lessons about backfires and boomerangs. South African Journal of Science, 115(3-4), pp.15-18.. S Afr J Sci. 2019;115(3/4), Art. #5585, 4 pages. https://doi.org/10.17159/ sajs.2019/5585

McHale, M.R., Beck, S.M., Pickett, S.T., Childers, D.L., Cadenasso, M.L., Rivers III, L., **Swemmer, L.**, Ebersohn, L., Twine, W. and Bunn, D.N., 2018. Democratization of ecosystem services—a radical approach for assessing nature's benefits in the face of urbanization. Ecosystem Health and Sustainability, 4(5), pp.115-131.

Meyer, L.C., Fuller, A., **Hofmeyr, M.**, **Buss, P.**, Miller, M. and Haw, A., 2018. Use of butorphanol and diprenorphine to counter respiratory impairment in the immobilised white rhinoceros (Ceratotherium simum). Journal of the South African Veterinary Association, 89.

Miller, M.A., **Buss, P.**, Parsons, S.D., Roos, E., Chileshe, J., Goosen, W.J., van Schalkwyk, L., de Klerk-Lorist, L.M., **Hofmeyr, M.**, **Hausler, G**. and **Rossouw, L.**, 2018. Conservation of White Rhinoceroses Threatened by Bovine Tuberculosis, South Africa, 2016–2017. Emerging infectious diseases, 24(12), p.2373.

Ndou, N.N., Palamuleni, L.G. and **Ramoelo, A.**, 2018. Modelling depth to groundwater level using SEBAL-based dry season potential evapotranspiration in the upper Molopo River Catchment, South Africa. The Egyptian Journal of Remote Sensing and Space Science, 21(3), pp.237-248.

Pohlin, F., **Buss, P.**, Miller, M., Steenkamp, G., Gleed, R., Poore, L., Boesch, J. and Zeiler, G., 2019. Etorphine-Ketamine Constant Rate Infusion for Maintenance of Anaesthesia in a Compromised White Rhinoceros (Ceratotherium simum). Case Reports in Veterinary Medicine, 2019.

Roos, E.O., Olea-Popelka, F., **Buss, P.**, de Klerk-Lorist, L.M., Cooper, D., van Helden, P.D., Parsons, S.D.C. and Miller, M.A., 2018. Seroprevalence of Mycobacterium bovis infection in warthogs (Phacochoerus africanus) in bovine tuberculosis-endemic regions of South Africa. Transboundary and Emerging Diseases, 65(5), pp.1182-1189.

Roos, E.O., Olea-Popelka, F., **Buss, P.**, Hausler, G.A., Warren, R., Van Helden, P.D., Parsons, S.D., de Klerk-Lorist, L.M. and Miller, M.A., 2018. Measuring antigen-specific responses in Mycobacterium bovis-infected warthogs (Phacochoerus africanus) using the intradermal tuberculin test. BMC veterinary research, 14(1), p.360.

Saraiva Okello, A.M.L., Uhlenbrook, S., Jewitt, G.P., Masih, I., **Riddell, E.S.** and Van der Zaag, P., 2018. Hydrograph separation using tracers and digital filters to quantify runoff components in a semi-arid mesoscale catchment. Hydrological processes, 32(10), pp.1334-1350.

Serieys, L.E., Bishop, J., Okes, N., Broadfield, J., Winterton, D.J., Poppenga, R.H., Viljoen, S., Wayne, R.K. and O'Riain, M.J., 2019. Widespread anticoagulant poison exposure in predators in a rapidly growing South African city. Science of the Total Environment, 666, pp.581-590.

Skubel, S.A., Dushenkov, V., Graf, B.L., Niu, Q., Poulev, A., Kalariya, H.M., **Foxcroft, L.C.** and Raskin, I., 2018. Rapid, field-deployable method for collecting and preserving plant metabolome for biochemical and functional characterization. PloS one, 13(9), p.e0203569.

van Wilgen, B.W., Munyai, T., Mnikathi, Z., Wilson, J.R., Morapi, T., Botha, L-A, Forsyth, T., Herbert, D., Rushworth, I., **Foxcroft, L.C.**, et al. 2018. The status of alien species. In: van Wilgen, B.W. & Wilson, J.R. (eds.) The status of biological invasions and their management in South Africa in 2017. South African National Biodiversity Institute, Kirstenbosch and DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch. pp. 47-70.

van Wilgen, B.W., Munyai, T., Wilson, J.R., Morapi, T., Forsyth, T., Rushworth, I., **Foxcroft, L.C.**, et al. 2018. The status of invaded areas. In: van Wilgen, B.W. & Wilson, J.R. (eds.) The status of biological invasions and their management in South Africa in 2017. South African National Biodiversity Institute, Kirstenbosch and DST-NRF Centre of Excellence for Invasion Biology, Stellenbosch. pp. 71-89.

van Wilgen, N.J., Gillespie, M.S., Richardson, D.M. and Measey, J., 2018. A taxonomically and geographically constrained information base limits non-native reptile and amphibian risk assessment: a systematic review. PeerJ, 6, p.e5850.

Richtersveld National Park
Michler, L.M., Treydte, A.C., Hayat, H. and Lemke, S., 2018. Marginalised herders: Social dynamics and natural resource use in the fragile environment of the Richtersveld National Park, South Africa. Environmental Development, 29, pp. 29-43.

Table Mountain National Park
Kock, A.A., Photopoulou, T., Durbach, I., Mauff, K., Meÿer, M., Kotze, D., Griffiths, C.L. and O'Riain, M.J., 2018. Summer at the beach: spatio-temporal patterns of white shark occurrence along the inshore areas of False Bay, South Africa. Movement ecology, 6(1), p.7.

Tankwa Karoo National Park
Harris, C., Buthelezi, N., Kahle, B., Kahle, R., Ramahala, K. and Smith, G., 2019. Stable isotope constraints on the fluid source of hydrothermal breccia pipes in the Tankwa Karoo depocentre, South Africa: Breakdown of authigenic minerals during sill intrusion. Basin Research, 31(1), pp.114-135.

McAuliffe, J.R., Hoffman, M.T., McFadden, L.D., Jack, S., Bell, W. and King, M.P., 2019. Whether or not heuweltjies: Context-dependent ecosystem engineering by the southern harvester termite, Microhodotermes viator. Journal of Arid Environments, 163, pp. 26-33.

Saaed, M.W., Jacobs, S.M., **Masubelele, M.L.**, Samuels, I., Khomo, L. and El-Barasi, Y.M., 2018. The composition of the soil seedbank and its role in ecosystem dynamics and rehabilitation potential in the arid Tankwa Karoo Region, South Africa. African Journal of Range & Forage Science, 35(3-4), pp.351-361.


© Kyle Smith

Appendix B: Conferences attended by SANParks staff

SANParks authors in bold

Conference / symposium / specialist meeting	Place	Date	Author(s)	Title of presentation
1st SADC Groundwater Conference: "Adapting to Climate Change in the SADC Region through Water Security – A Focus on Groundwater".	OR Tambo Conference Centre, Johannesburg	26 - 28 September 2018	**Petersen R**, du Toit W, Verster V, **Strydom T**, Vilhoth K and Bomo M	Hydro-geological dynamics of Mpungubwe National Park. Tuli-Karoo Transboundry Aquifer (TBA)
2nd Annual Garden Route Interface Meeting	Sedgefield, Western Cape	2 - 4 October 2018	**Freitag-Ronaldson S**	Imagining with stakeholders – cooperatively painting the park's desired future state
	Sedgefield, Western Cape	2 - 4 October 2018	Hayes J, **Smith K** and Maphanga B	Exploring the Knysna Estuary's potential watercraft carrying capacity
	Sedgefield, Western Cape	2 - 4 October 2018	**Moolman L**	When the last elephant remains
	Sedgefield, Western Cape	2 - 4 October 2018	**Roux D**	People-place interactions in national parks and their translation into cultural ecosystem services
	Sedgefield, Western Cape	2 - 4 October 2018	**Russell I** and **Britton J**	Avian botulism in the Garden Route - causes and consequences
	Sedgefield, Western Cape	2 - 4 October 2018	**Smit IPJ**	Use it or lose it … or save it? Tourist usage of water and electricity in the Kruger National Park
	Sedgefield, Western Cape	2 - 4 October 2018	**Vermeulen W**	Demand for and constraints with medicinal plant harvesting from the Garden Route National Park
17th Annual Savanna Science Networking Meeting	Skukuza, Kruger National Park, Mpumalanga	4 - 7 March 2019	**Ferreira S**	A poacher's chase for a rhino guard?
	Skukuza, Kruger National Park, Mpumalanga	4 - 7 March 2019	**Foden WB**, **van Wilgen NJ**, **Masubelele ML** & Coldrey K	Preparing for climate change in South African National Parks
	Skukuza, Kruger National Park, Mpumalanga	4 - 7 March 2019	**Foxcroft LC**	Exploring patterns of alien plant invasions in Kruger National Park

17th Annual Savanna Science Networking Meeting	Skukuza, Kruger National Park, Mpumalanga	4 - 7 March 2019	**Smit IPJ, Ferreira S, Greaver C** and **Pienaar D**	A multi-decadal Strategic Adaptive Management experiment: Mega-herbivore response to droughts under different management regimes
	Skukuza, Kruger National Park, Mpumalanga	4 - 7 March 2019	**Swemmer LK**	Who are our neighbours? People, perceptions, places and priorities
19th Annual Marine and Coastal Educators Network Conference	Storms River Mouth Rest Camp, Eastern Cape	14 January 2019	**de Morney M**	Engaging the youth in conservation science
40th Fynbos Forum	Goudini Spa Resort, Rawsonville, Western Cape	31 July - 3 August 2018	**Sibiya T**	Progress towards the recovery of fynbos vegetation in pine plantation exit areas, Goudveld,Garden Route National Park
45th Annual Research Symposium on the Management of Biological Invasions in Southern Africa.	University of Venda, Thohoyandou, Limpopo	3 - 6 July 2018	**Foxcroft LC**	Invasive alien species know no boundaries
53rd Annual Grassland Society of Southern Africa Symposium	ARC Roodeplaat, Gauteng, 23-26 July 2018	23 - 26 July 2018	**Strydom T**, Rowe T, **Riddell E**, **Govender N**, Lorentz S & le Roux P	Pyro-hydrological interactions in African savanna soils
African Rhino Specialist Group	Gross Barmen, Namibia	4 - 11 February 2019	**Ferreira S**	Doing more of not the same
Arid Zone Ecology Forum (AZEF)	Robertson, Western Cape	16 - 18 October 2018	Adams T, Brown L and **Bezuidenhout H**	The Ecology of Namaqualand Sand Fynbos Vegetation type
	Robertson, Western Cape	16 - 18 October 2018	Piers L, Samuels MI and **Masubelele ML**	A landscape functionality assessment along biome boundary between the succulent karoo and desert biomes.
	Robertson, Western Cape	16 - 18 October 2018	Samuels M.I; Cupido C.F, **Masubelele ML**, Swarts MBV, Van Orsdol K and Lynes L.S	Socio-ecological vulnerability to climate change of a small farming community in the arid zone of South Africa
European Association of Zoos and Aquaria	Talinn Zoo, Estonia	21 - 27 May 2018	**Ferreira S**	The distraction of managing distant wildlife markets ignores local social injustices
INSAKA Symposium 2018	Mopani Rest Camp, Kruger National Park	12 - 14 June 2018	**Ferreira S**	People well-being and saving species: It's all about sex

INSAKA Symposium 2018	Mopani Rest Camp, Kruger National Park	12 - 14 June 2018	**Petersen R** and **Riddell E**	How do we monitor the socio-ecological benefits of implementing the Ecological Reserve?
	Mopani Rest Camp, Kruger National Park	12 - 14 June 2018	**Smit IPJ**, **Roux D**, **Swemmer L**, Boshoff N and Novellie P	Protected areas as outdoor classrooms and global laboratories: Intellectual ecosystem services flowing to-and-from a National Park
	Mopani Rest Camp, Kruger National Park	12 - 14 June 2018	**Swemmer LK**, Mdungasi P, Mmatho W, Shibambu D, Landela R and Twine W	"It's not about the worm" – the impact of resource use, Kruger National Park
National Global Change Conference	University of Limpopo	3 - 6 December 2018	**Phophe A** and **Masubelele M**	Taking the first step to reduce carbon emissions in South African National Parks (SANParks)
SAEON Indibano (student conference)	Wits Rural Facility	16 - 18 September 2018	**Smit IPJ**	Science-Management engagement in the KNP
SANCIAHS Hydrology Symposium	Skukuza, Kruger National Park, Mpumalanga	18 - 20 September 2018	**Strydom T**, Rowe T, **Riddell E**, **Govender N**, Lorentz S & le Roux P	Effect of fire and herbivory on basalt-derived soils
South African Wildlife Management Association Conference (SAWMA)	ATKV Klein Kariba Resort, Bela Bela	9 - 14 September 2018	**Swemmer LK**	"It's not about the worm" – the impact of resource use, Kruger National Park
Spatial Planning for Protected Areas in Response to Climate Change African Regional meeting (SPARC)	Calders Hotel, Fish Hoek, Western Cape	14 - 15 January 2019	**Foden W**	SPARC Africa: programme outline and preliminary results
Stockholm Seminars	Stockholm Resilience Centre, Stockholm	30 November 2018	**Roux D**	Reflections on a transdisciplinary journey in conservation science.
Sustainability Research Unit (SRU) Associates Symposium	Nelson Mandela University, George Campus	6 August 2018	**Roux D**	Cultural ecosystem services as emergent properties of people-place interaction in national parks
The Conservation Symposium	St Ives, KwaZulu Natal Midlands	5 - 9 November 2018	**Cheney C**, **van Wilgen NJ**, **Foxcroft LC**, McGeoch MA and Esler K.J	Factors influencing management effectiveness of alien plant control programmes in Table Mountain National Park
	St Ives, KwaZulu Natal Midlands	5 - 9 November 2018	**Ferreira S**	Gigantic elephant lessons for tiny places.
	St Ives, KwaZulu Natal Midlands	5 - 9 November 2018	Winterton DJ and van Wilgen N	Exploring the influence of land management on occupancy and temporal activity of sympatric herbivores

NOTES

NOTES

Parks

Connect

People