FitzPatrick Institute of African Ornithology

DST-NRF Centre of Excellence
University of Cape Town

Annual Report 2019

FRONT COVER: **A male Grey-winged Francolin *Scleroptila afra* advertising the presence of his covey in their territory in the West Coast National Park (Photo: Andre Botha).**

REPORT LAYOUT: HILARY BUCHANAN

FitzPatrick Institute Advisory Board 2019

Mark Anderson (BirdLife South Africa)
Dr Pippin Anderson (ENGEO, UCT)
Dr Graham Avery (WESSA)
Michael Buckham (co-opted)
Dawie Chamberlain (co-opted) – May-Dec
Dean Ferreira (co-opted)
Prof. Sue Harrison (DVC Research, UCT)
Vernon Head (co-opted)
A/Prof. Muthama Muasya (HoD, Biological Sciences, UCT)
Marina Niven (FitzPatrick Memorial Trust)
Prof. Maano Ramutsindela (Dean, Faculty of Science) – Chairperson
Prof. Peter Ryan (Director, FIAO)
Francois van der Merwe (co-opted)

Centre of Excellence Steering Committee 2019

Prof. Mike Cherry (Botany & Zoology, U. Stellenbosch)
Prof. John Donaldson (SANBI)
Prof. Sue Harrison (DVC, Research, UCT) – Chairperson
A/Prof. Muthama Muasya (HoD, Biological Sciences, UCT)
Prof. Maano Ramutsindela (Dean, Faculty of Science)
Prof. Peter Ryan (Director, FIAO)
Nathan Sassman (NRF)
Dr Marilet Sienaert (Research Office, UCT)
Dr Hanneline Smit-Robinson (BirdLife South Africa)

Contents

Director's report

2019 was another busy and productive year for the Fitz and the broader Centre of Excellence (CoE). The year's highlights are summarised in Rob Little's report on the CoE on pages 5-6, but one statistic bears repeating. The total count of scientific publications, 153, was one more than 2018's record of 152. This amounts to 20% of the total number of papers produced by all 14 DST-NRF Centres of Excellence in South Africa, despite the Fitz receiving less funding than most other Centres. More importantly, there was an increase in the number of papers in high impact journals, with 27 papers in journals with 2-year impact factors >5, up from 16 in 2018. We are also proud of the more than 50 popular articles published. There is little doubt that a culture of performing and communicating high-quality and relevant science is entrenched within the Fitz.

This success is thanks entirely to the enthusiasm and passion of the amazing team of academics, research associates and students that constitutes the broader Fitz family. I owe them all a debt of thanks for their commitment to excellence in the face of an increasingly challenging funding environment. It is gratifying when their efforts are recognised. I'd like to highlight two awards in 2019: Claire Spottiswoode became the youngest ever recipient of the Gill Memorial Award for her lifetime contribution to southern African ornithology, and Pierre Pistorius was recognised as Nelson Mandela University's Researcher of the Year for the third time! I also congratulate the many Fitz students who graduated in 2019; I am confident that your time at the Fitz has prepared you for a rewarding and relevant career, at a time when there is such a pressing need for environmental scientists.

On the staffing front, 2019 saw only one new appointment, with Janine Dunlop replacing Susan Mvungi as Niven Librarian in March. Janine has a long history of working at UCT, both in the library system and in broader communications, and rapidly settled into her new role. We could have added another full-time researcher to the Fitz team in 2019. Former PhD student and post-doc Megan Murgatroyd, who has been doing excellent work with Arjun Amar developing practical tools to reduce the impacts of wind energy facilities on raptors, was appointed by Hawk Watch International as their first African-based researcher. As such, she was looking for a home base in Africa, and the Fitz was more than happy to accommodate her. Sadly, despite taking the matter to DVC level, we were unable to negotiate the institutional roadblocks erected by this atypical funding model, and Megan moved to the Endangered Wildlife Trust. She will continue to work with the Fitz, but this was an opportunity lost. UCT needs to become more flexible in exploiting such partnerships if it wishes to maintain momentum in its internationalisation goal and remain the leading research institution on the continent.

Funding for the Fitz CoE, recognised as one of the original six centres in 2004, was expected to end in 2020, after the third 5-year funding cycle. Over the last two years, various models for phasing out CoE support have been discussed with the Department of Science and Technology (now the Department of Science and Innovation), which funds the CoEs, and the National Research Foundation, which manages CoE grants. However, no decision was taken, despite the imminent end of the current funding cycle. The only guarantee was that existing students would continue to receive support until the end of their studies. Finally, in November 2019, just two days before we were scheduled to present the CoE business plan for 2020, we received notice that CoE funding would continue for three years, until the end of 2022, at the same level received in 2019. During this transitional period, the Centres are expected to engage with government departments and other relevant stakeholders that benefit from the CoE research to come up with alternative funding streams.

This is good news for the immediate future of the Fitz. It ensures continued funding for Dr Susie Cunningham's position, which is central to both the Conservation Biology MSc programme as well as the flag-ship 'hot birds' research project. However, we shall struggle to accommodate the new ministerial guidelines on student support that require 95% of bursary funds to go South African students, with 90% going to 'black' South Africans. This raises serious challenges to funding excellent white South African students and black students from the rest of Africa; applications from each of these groups far exceed in number those from the NRF's target group for bursaries. Increasingly, the Fitz is going to have to look outside the NRF for student support as well as research funding.

Another looming funding challenge is to continue to support SABAP2, CWAC and the other citizen science projects inherited from the Animal Demography Unit in 2018. These datasets provide some of the best data to understand the impacts of global change on wetlands (CWAC) and more broadly across South Africa (SABAP). At the time of writing, there is still no clarity on whether government funding will be forthcoming to support these crucial projects beyond the end of February 2020, and the Fitz has already spent close to half a million Rand on them over the last two years. I have committed to supporting SABAP2 and other bird-related projects until the end of 2020, but we have to come up with a viable external funding model during this time as we cannot afford to carry these projects from Fitz reserves beyond this year.

2020 is the Fitz's 60th anniversary. I have worked at the Fitz, in one form or another, for 40 of those 60 years, and indeed have just returned from the Northern Cape, where I repeated some of the shorebird counts I made with John Cooper in 1980. Emeritus Professors Tim Crowe and Roy Siegfried have put considerable effort into drafting a history of the Fitz to commemorate its diamond jubilee. While it is not ideal for some of the protagonists to write such a document, there's no doubt that Roy in particular was 'in the room where it happened' when many of the pivotal decisions were made that shaped the modern Fitz. I am editing this history, with the intention of making it available online later this year. For me, the most interesting part has been the account of the Fitz's humble origins. I am confident that Cecily Niven would be proud of how her vision for an African institute of ornithology has flourished.

Peter Ryan, February 2020

For me, 2019 was the year of the bottle. My long-term surveys of litter stranded on Inaccessible Island resulted in a paper, published in the prestigious *Proceedings of the National Academy of Sciences of the USA*, showing that drink bottles have increased faster than any other type of litter at the island. Over the last three decades there has been a shift from mainly South American (as one would expect given the location of the island downstream from South America) to Asian bottles. And most Asian bottles washing ashore in 2018 were less than two years old, thus almost certainly dumped from ships. Building on these results, during 2019 I collected similar data for bottles along the South African and Kenyan coasts. Not surprisingly, most are made locally, but more than one quarter are from foreign sources – almost all from Asia. And even in the remote Pitcairn islands, in the central South Pacific, the same manufacturers predominate. Since MARPOL Annex V banned the dumping of plastics at sea in 1989, we have accepted that most marine litter comes from land-based sources. The International Maritime Organisation needs to increase pressure on international shipping to stop illegal dumping through stricter monitoring of the use of port waste reception facilities (Photo: Ansje Lohr).

Staff, Students and Associates

UCT GRADUATES

PhD
Ben Dilley

MSc
Laurie Johnson
Ditiro Moloto

Conservation Biology MSc
Kerry-Anne Grey
Amy Hoffenberg
Sandra Hörbst
Rebecca Muller
Thinabakho Ncube
Michelle Schroeder
Clara Steyn
Olivia Venter
Joshua Weiss

NEW UCT STUDENTS

PhD
Timothy Aikins Khan (Robert Thomson)
Angela Moreras (Robert Thomson)
Olufemi Olubodun (Robert Thomson)
Vonica Perold (Peter Ryan)

MSc
Robin Colyn (Peter Ryan)
Farisayi Dakwa (Peter Ryan)
Monique du Plessis (Claire Spottiswoode)
David Lloyd-Jones (Claire Spottiswoode)
Jess Lund (Claire Spottiswoode)
Samantha McCarren (Anina Coetzee)

Upgrade from MSc to PhD
Kyle-Mark Middleton

Conservation Biology MSc
Eleven students began the CB MSc in January 2019.

Applied Ocean Sciences MSc
Brandon Opie (project supervisor: Peter Ryan)

BSc Hons
Justin Jacobs (Robert Thomson)
Christie Munro (Peter Ryan)
Elena Piller (Peter Ryan)
Taylyn Risi (Susie Cunningham)
Michelle Vrettos (Arjun Amar)
Kyle Walker (Arjun Amar)

Academic Staff

Director:
Prof. Peter Ryan, PhD (Cape Town)

Academic and Research Staff:
Assoc. Prof. Arjun Amar, PhD (Aberdeen)
Dr Susan Cunningham, PhD (Massey)
Prof. Claire Spottiswoode, PhD (Cambridge)
Dr Robert Thomson, PhD (Oulu)

Honorary Professor:
Prof. David Cumming, PhD (Rhodes)

External CoE Team Members
Asst Prof. Rauri Bowie, PhD (Cape Town) – UC, Berkeley
Prof. Derek Engelbrecht, PhD (Limpopo) – U. Limpopo
Prof. Andrew McKechnie, PhD (Natal) – U. Pretoria
Dr Pierre Pistorius, PhD (Pretoria) – NMU
Dr Chevonne Reynolds, PhD (Cape Town) – Wits

Honorary Research Associates/Affiliates
Dr Phoebe Barnard, PhD (Uppsala)
Dr Rita Covas, PhD (Cape Town)
Prof. Graeme Cumming, PhD (Oxford)
Dr Tom Flower, PhD (Cambridge)
Dr Wendy Foden, PhD (Wits)
Dr David Grémillet, PhD (Kiel)
Dr Azwianewi Makhado, PhD (Cape Town)
Dr Alistair McInnes, PhD (Cape Town)
Dr Patrick O'Farrell, PhD (Cape Town)
Prof. Steven Redpath (PhD, Leeds)
Assoc. Prof. Mandy Ridley, PhD (Cambridge)
Dr Andrea Santangeli, PhD (Helsinki)
Dr Rob Simmons, PhD (Wits)
Dr Ross Wanless, PhD (Cape Town)

Research Associates
Dr Steve Boyes, PhD (KwaZulu-Natal)
Dr Callan Cohen, (PhD, Cape Town
Dr Timotheé Cook, PhD (La Rochelle)
Dr Richard Dean, PhD (Cape Town)
Dr Claire Doutrelant, PhD (Paris)
Dr Robert Flood (PhD, City University, London)
Dr Gabriel Jamie, PhD (Cambridge)
Dr Andrew Jenkins, PhD (Cape Town)
Dr Genevieve Jones, PhD (Cape Town)
Dr Grant Joseph, PhD (Cape Town)
Dr Alan Lee, PhD (Manchester Metropolitan)
Dr Ian Little, PhD (Cape Town)
Dr Kristi Maciejewski, PhD (NMU)
Dr Rowan Martin, PhD (Sheffield)
Dr Martim Melo, PhD (Edinburgh)
Dr Antoni Milewski, PhD (Murdoch)
Michael Mills, MSc (Cape Town)
Prof. Sue Milton, PhD (Cape Town)
Dr Lorien Pichegru, PhD (Strasbourg)
Dr Sebataolo Rahlao, PhD (Cape Town)
Dr Yan Ropert-Coudert (PhD, NIPR, Tokyo, Japan)
Dr Colleen Seymour, PhD (Cape Town)
Dr Jessica Shaw, PhD (Cape Town)
Dr Richard Sherley, PhD (Cape Town)
Dr Antje Steinfurth, PhD (Kiel)
Dr Gareth Tate, PhD (Cape Town)
Dr Jane Turpie, PhD (Cape Town)
Jessie Walton

Support Staff

Manager, DST-NRF CoE
Rob Little, PhD (Cape Town)

Principal Technical Officer
Gonzalo Aguilar

Information System Specialists
Michael Brooks
Dr René Navarro, PhD (Cape Town)

Administrative Assistants
Hilary Buchanan, BA, HDipLib (Cape Town)
Anthea Links

Senior Secretary, DST-NRF CoE
Carmen Smith

Niven Library
Librarian: Janine Dunlop, MIT (Lib.Sci) (Pretoria)
Assistant librarian: Phelisa Hans

Project Assistants
SABAP2: Sanjo Rose, BSc (Hons) (Cape Town)
SAFRING: Lee Kelly, Jan-March, Kim Kelly Hunt, Apr-Dec

Ad hoc Research Assistants
Cameron Blair, Rion Cuthill, Natasha Else, Shannon Hardisty, Cheslyn Hickley, Carrie Hickman, Yi-Ting Ho, Sally Hofmeyr, Alan Lee, Colleen Lindberg, Kyle McClean, Burghen Siebert, Joshua Weiss.

Students

Post-doctoral fellows
Dr Diana Bolopo, PhD (Valladolid)
Dr Anina Coetzee, PhD (Stellenbosch)
Dr Pietro D'Amelio, PhD (Munich), April-Dec
Dr Ben Dilley, PhD (Cape Town), Sept-Dec
Dr Susan Miller, PhD (TUT)
Dr Megan Murgatroyd, PhD (Cape Town), Jan-June
Dr Chima Nwaogu, PhD (Groningen & St Andrews)
Dr Dayo Osinubi, PhD (Christchurch), Jan- Feb
Dr Petra Sumasgutner, PhD (Vienna), Jan-July
Dr Jessica van der Wal, PhD (St Andrews)

Doctoral
Emmanuel Adekola, MSc (Jos)
Timothy Aikins Khan, MPhil (Ghana)
Amanda Bourne, MSc (Cape Town)
Christiaan Brink, MSc (Cape Town)
Daniël Cloete, MSc (Cape Town)
Ben Dilley, BSc (Hons) (Cape Town)
Carla du Toit, BSc (Hons) (Cape Town)
Selena Flores, BSc (San Diego)
Anthony Lowney, MSc (Manchester)
Luke McClean, BSc (Queens)
Kyle-Mark Middleton, BSc (Hons) (Pretoria)
Angela Moreras, MSc (Bielefeld)
Benjamin Murphy. MSc (Exeter)
Carina Nebel, MSc (Vienna)
Olufemi Olubodun, MSc (Ibadan)
Nicholas Pattinson, MSc (NMU)
Vonica Perold, MSc (Pretoria)
Stefan Schoombie, MSc (Cape Town)
Kim Stevens, BSc (Hons) (Cape Town)

MSc by dissertation
Robin Colyn, MTech (CPUT)
Farisayi Dakwa, BSc (Hons) (NUST)
Monique du Plessis, BSc (Hons) (Stellenbosch)
Campbell Fleming, BSc (Hons) (Cape Town)
Laurie Johnson, BSc (Hons) (Cape Town)
Jess Lund, BSc (Hons) (Cape Town)
David Lloyd-Jones, BSc (Hons) (Canterbury)
Ditiro Moloto, BSc (Hons) (Limpopo)
Alexis Osborne, BSc (Hons) (Cape Town)
Abigail Ramudzuli, BSc (Hons) (Limpopo)
Miqkayla Stofberg, BSc (Hons) (Cape Town)
Rona van der Merwe, BSc (Hons) (Stellenbosch)

Masters in Conservation Biology 2019/20
René Brink, BSc (Hons) (Cape Town)
Cecilia Cerrilla, BSc (Brown, USA)
Conor Eastment, BSc (Hons) (Cape Town)
Kathryn Gardner, BSc (Hons) (Stellenbosch)
Jennifer Gedert, BSc (Idaho)
Jack Harper, BSc (Hons) (Liverpool)
Gilson Montrond, BSc (Cape Verde)
Matthew Orolowitz, BSc (Hons) (Stellenbosch)
Kate Sheridan, BSc (Southampton)
Debbie Stanbridge, BSc (Hons) (Cape Town)
Luke Wilson, BSc (Hons) (Cape Town)

Masters in Conservation Biology 2018/19
Kerry-Ann Grey, BSc (Stellenbosch)
Amy Hoffenberg, BSc (Hons) (Cape Town)
Sandra Hörbst, BSc (Leopold-Franzens)
Xolani Mabaso, BSc (Hons) (UKZN)
Rebecca Muller, BSc (Hons) (Cape Town)
Thinabakho Ncube, BSc (Hons) (Wits)
Michelle Schroeder, BSc (Humbolt State)
Clara Steyn, BSc (Hons) (Cape Town)
Daryl van der Merwe, BSc (Hons) (Pretoria)
Olivia Venter, BSc Chem Eng (Cape Town)
Joshua Weiss, BSc Hons (Wits)

Applied Ocean Sciences MSc
Brandon Opie BSc (Hons) Cape Town

BSc Hons
Justin Jacobs, Christie Munro, Elena Piller, Taylyn Risi, Michelle Vrettos, Kyle Walker

Externally registered students
Post-doctoral fellow
NMU– Alistair McInnes, PhD (Cape Town) – Jan-July

Doctoral
Bordeaux – Adrien Pajot
Cambridge – Marienn Collins Attwood, Tanmay Dixit
Montpellier – André Ferreira, Aloïs Robert
NMU – Tegan Carpenter-Kling, Katharina Reusch, Gwendoline Traisnel
Porto – Rita Fortuna, Sandra Reis
Pretoria – Shannon Conradie, Marc Freeman, Ryno Kemp, Celiwe Ngcamphalala, Matthew Noakes, Michelle Thompson
Rhodes – Krista Oswald
Strasbourg – Martin Quque
UCT –Edmund Rodseth (MCB)
Western Australia – Camilla Soravia

MSc by dissertation
CIBIO, Porto - Inês Duarte, Sandra Esteves, Barbara Freitas, António Viera
Lund – Johan Jensen
Montpellier – Louis Bliard
NMU –Catherine Currin, Ilana Engelbrecht, Tayla Ginsberg, Lilli Ruiters, Praxedes Rukuni, Makabongwe Sigqala
Pretoria – Barry van Jaarsveld

BSc Hons
Montpellier – Claire Shigo, Delphine Dubal
NMU – Shamiso Banda
Pretoria – Michelle Bouwer, Andries Janse van Vuuren

CoE research and education highlights

- We conducted 27 research projects including four new projects during 2019.
- The FIAO CoE supported 26 PhDs, 44 MScs and 11 Postdoctoral Fellows.
- A record 153 papers were published in peer-reviewed journals, including 44 papers in journals with ISI impact factor ratings ≥3.5.
- 54 popular articles and six book chapters were published.
- CoE members served on the editorial boards of 31 scientific journals and reviewed 101 papers for 56 peer-reviewed journals.

The Fitz Centre of Excellence (CoE) includes partners at four other South African institutions. The following summary includes students and outputs from all these partners.

The 27 research projects during 2019 included four new projects: using raptors to monitor environmental contamination in South Africa; waterbird dispersal of aquatic invasive weeds; the impact of Sociable Weaver nests on Camelthorn trees; and on understanding the impacts of landscape structure on urban bird communities.

The Fitz CoE continued to greatly exceed its publication target with a new record of 153 papers published in peer-reviewed journals in 2019, including 44 papers in journals with ISI impact factor ratings ≥3.5. Seven chapters in semi-technical books and 54 popular articles were also published.

Prof. Claire Spottiswoode was awarded the Gill Memorial Medal by BirdLife South Africa in May 2019 for her outstanding lifetime contributions to ornithology. She is the youngest recipient of the medal amongst a group of southern Africa's distinguished ornithologists since its inaugural award in 1960. Claire also co-edited a special issue of *Philosophical Transactions of the Royal Society B* on the theme "Co-evolutionary biology of brood parasitism: from mechanism to pattern".

Post-doc Petra Sumasgutner received a Theodor Körner Fund award in Hofburg, Vienna, Austria on 10 May 2019 in recognition of scientific advances in Austria for her novel approach of extracting DNA from the feathers of falconry Golden Eagles *Aquila chrysaetos*.

Education and training

During 2019, the Fitz CoE supported 26 PhD, 44 MSc and six BSc Honours students, of whom 20 (29%) were black and 40 (57%) were women. Eleven Post-doctoral fellows were registered. The centre graduated 17 students during 2019 (2 PhD, three MSc by dissertation, 11 MSc Conservation Biology and one BSc Honours).

Jessica van der Wal, Pietro D'Amelio, Chima Nwaogu and Ben Dilley joined the Fitz as Post-docs during 2019 to work on honeyguide mutualism, socialism in birds, urban raptors and seabird/island conservation, respectively. Post-doc Dayo Osinubi left at the end of February 2019 to join BirdLife International as their Conservation Programmes Coordinator in the BirdLife Africa Partnership Secretariat and is now based in Accra, Ghana. Megan Murgatroyd left at the end of June 2019 to join Hawk Watch with the Endangered Wildlife Trust but will remain closely associated with the Fitz. Petra Sumasgutner left at the end of July to join the Konrad Lorenz Institute for Behavioural Biology in Grünau and the Department of Cognitive Biology at the University of Vienna, Austria. Alistair McInnes also left at the end of July to join BirdLife South Africa as their Seabird Programme manager.

Collaboration and service rendering

FIAO CoE members served on the editorial boards of 31 scientific journals and as members of 90 membership and advisory fora. They served the broader scientific community by participating on scientific steering committees and working groups, by reviewing project proposals for science funding agencies, and by reviewing 101 papers for 56 peer-reviewed international and local journals during 2019.

The Fitz conducted a broad range of close collaborative working relationships with at least 100 scientific peers and a variety of conservation NGOs and governmental organisations both nationally and internationally. The Fitz continues to build much-needed African capacity in the broad arena of biodiversity conservation. Eleven

prominent research and conservation partners visited the Fitz and presented seminars during 2019.

PhD student Carla du Toit featured in a live broadcast on the ecology and conservation of suburban Hadedas on the TV news channel eNCA.

Information brokerage

Fitz staff and students presented research findings at 17 international and 11 local conferences during 2019. They also presented more than 50 seminars and illustrated talks at numerous universities, bird clubs, and membership-based societies, and maintained a broad range of collaborative working relationships with scientific peers and a variety of conservation NGOs and governmental organisations, both nationally and internationally. Numerous projects were reported on TV, radio and the print media, in addition to extensive social media coverage.

Research highlights

Prof. Peter Ryan and colleagues published a high impact paper titled 'Rapid increase in Asian bottles in the South Atlantic Ocean indicates major debris inputs from ships' in the *Proceedings of the National Academy of Sciences* (PNAS) which received extensive media attention including the BBC and *The Economist.* The 'hot birds' team also celebrated their 10th anniversary with a paper in PNAS summarising the likely impacts on ongoing climate change on birds in the arid regions of South Africa.

Post-doc Megan Murgatroyd and A/Prof. Arjun Amar, together with colleagues from the UK, published a paper in *Nature Communications* which received considerable media coverage. We often think wildlife crime doesn't exist in Europe or outside of developing countries but this research, based on satellite tracking data, identified widespread illegal killing of from Hen Harriers *Circus cyaneus* in areas managed for driven grouse hunting. This is a major wildlife crime which until now has been largely dismissed or denied by pro-hunting groups.

Peter Ryan and PhD student Ben Dilley contributed to a paper on seabird population changes following mammal eradications from islands. The paper generated immediate impact and visibility, contributing significantly to the advancement of island restoration programmes, and was one of *Animal Conservation's* top downloaded papers in the year following its publication.

Two papers by former CoE PhD student Tshifhiwa Mandiwana-Neudani, Profs Tim Crowe and Rauri Bowie, and Dr Rob Little were published on the taxonomy, phylogeny and biogeography of African spurfowls and francolins. This saw the recognition of 16 new species, a radical reduction in the number of subspecies, and proposed several new genera within the francolins.

Claire Spottiswoode receiving the Gill Memorial Medal from Prof. Colleen Downs, Honorary President of BirdLife South Africa (Photo: Arno Ellmer).

Coevolutionary arms races in brood-parasites and their hosts

Coevolution is the process by which two or more species reciprocally influence one another's evolution, and can escalate to produce beautifully refined adaptations. Brood-parasitic birds, the cheats of the bird world, give us an ideal opportunity to study coevolution in the wild. Coevolutionary "arms races" can arise as hosts evolve defences such as rejecting parasitic eggs, which imposes natural selection for parasitic counter-adaptations such as mimicry of host eggs, and in turn for ever more sophisticated defences from hosts. Three long-term projects address different aspects of this fascinating model system for coevolution.

Robert Thomson's team work in Finland, where their research focuses on how host pairs of Common Redstarts *Phoenicurus phoenicurus* can decrease the chance of a Common Cuckoo *Cuculus canorus* laying an egg in their nest. Hosts that are able to avoid parasites would decrease the fitness costs of parasitism; the earlier that avoidance occurs during the breeding cycle would further minimize these costs. Therefore, host adaptations occurring prior to egg laying would be especially beneficial, because the host's entire clutch is preserved if frontline defences are successful. The Finnish project investigates these frontline defences (nest site choice, habitat selection, nest building decisions) and the counter-adaptations by parasites (prospecting and laying strategies), which have received little attention to date. Redstarts are the only regular cuckoo host that breeds in cavities which makes it difficult for female cuckoos to lay eggs and for their newly-hatched chicks to evict host eggs/chicks.

Claire Spottiswoode's team works in Zambia on three questions. First, how do interactions between species generate diversity among individuals? Specifically, how do biological arms races between hosts and parasites shape phenotypic diversity in both parties? For example, parasites diversify to mimic multiple hosts, and in response hosts sometimes diversify with defensive adaptations to foil mimicry, such as visual 'signatures' of identity. Second, how is specialisation to different coevolutionary partners genetically maintained? The genetic basis of signature-forgery arms races played out by brood parasitic birds is currently almost entirely unknown. In collaboration with Prof. Michael Sorenson and his lab at Boston University, we are using genomic approaches to ask how specialised adaptations to different host species (mimicry of host eggs) are maintained within a single parasitic species (e.g. Cuckoo Finches *Anomalospiza imberbis* and Greater Honeyguides *Indicator indicator*) in the absence of parasite speciation. Reciprocally, we are also interested in the genetic basis of host defences, and whether convergent genetic mechanisms have evolved in their corresponding parasitic mimics. Third, what is the role of phenotypic plasticity (such as developmental differences and learning) in coevolution? We are interested in how such plasticity might facilitate parasitic exploitation of new host species in the initial absence of appropriate genetic adaptations, and addressing this both within and between species of parasitic finches and honeyguides.

Fitz Research Associate Jessie Walton has been studying a population of Brown-backed Honeybirds *Prodotiscus regulus* which parasitise Karoo Prinias *Prinia maculosa* at a high rate in the Bot River area of the Western Cape. The remarkable adaptation that we are investigating is their blue eggs, highly unusual in piciform birds, that broadly mimic those of their hosts. Moreover, up to three honeybird chicks are raised in the same host nest, despite killing host young with their bill hooks. How honeybirds escape being killed by their nestmates remains an intriguing mystery.

Activities in 2019

- Angela Moreras joined the project as a PhD student. Her first task was to lead the Finnish field season where she collected long-term data on Redstart nest location, decisions and parasitism rates while also doing a field experiment that manipulated Redstart nest

Mairenn Collins Attwood setting up an experiment at a drongo nest (Photo: Jess Lund).

parasitism vulnerability and measured behavioural responses.

- Justin Jacobs investigated prospecting of Common Cuckoos at Redstart nests as part of his UCT BSc Hons thesis. This rarely reported behaviour in brood parasites was surprisingly common in the study system.
- In the rainy season in Zambia, Gabriel Jamie completed sampling on the genetic basis of egg signatures in Tawny-flanked Prinias. Tanmay Dixit began PhD field research on the evolution of prinia egg signatures and Cuckoo Finch egg forgeries. Tanmay and Jess Lund hosted Stephanie McClelland, a PhD student from Royal Holloway (U. London).
- Two new students began MSc research on coevolution between Fork-tailed Drongos *Dicrurus adsimilis* and their African Cuckoo *Cuculus gularis* parasites: Jess Lund is studying the genetic and phenotypic consequences of egg signatures in drongos and Mairenn Collins Attwood is studying hawk mimicry by African Cuckoos.
- After four seasons of fieldwork in Zambia, Luke McClean completed writing up his PhD entitled "Coevolution between brood-parasitic honeyguides and their hosts" which reveals some fascinating adaptations and counter-adaptations.

Highlights

- Gabriel visited our colleagues at Copperbelt University in Kitwe, Zambia, to share our research findings and plan future collaborative activities. He gave several outreach talks at schools and science festivals in Zambia and the UK.
- The special issue of *Philosophical Transactions of the Royal Society of London B* co-edited by Claire Spottiswoode titled "The coevolutionary biology of brood parasitism: from mechanism to pattern" was published in February.
- This special issue contained two empirical papers from our Zambian project: "Higher-level pattern features provide additional information to birds when recognizing and rejecting parasitic eggs" and "Convergent evolution of reduced eggshell conductance in avian brood parasites".
- It also contained two theoretical review papers part-inspired by our work in Zambia: "Vive la difference! Self/non-self recognition and the evolution of signature polymorphism in arms races with parasites" and "The coevolutionary biology of brood parasitism: a call for integration".
- Claire presented recent highlights from our Zambian project at the "Frontiers in Behavioural Research" symposium at the Max Planck Institute for Ornithology, Seewiesen, Germany.

Key co-supporters

European Research Council; National Geographic Society; Max Planck Institute for Evolutionary Anthropology; DST-NRF CoE grant; British Ecological Society; Association for the Study of Animal Behaviour; American Ornithological Society.

Research team 2019

Dr Robert Thomson (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
Dr Diana Bolopo (FIAO, UCT)
Dr Nicholas Horrocks (U. Cambridge)
Dr Gabriel Jamie (U. Cambridge)
Prof. Michael Sorenson (Boston University)
Dr Rose Thorogood (U. Helsinki, Finland)
Dr Jere Tolvanen (U. Oulu, Finland)
Jessie Walton (FIAO, UCT)

Students: Tanmay Dixit (PhD, Cambridge); Luke McClean (PhD, UCT); Angela Moreras (PhD, UCT); Mairenn Collins Attwood (MPhil, Cambridge); Jess Lund (MSc, UCT); Justin Jacobs (BSc Hons, UCT).

Research assistants:
Finland: Joshua Strauss
Zambia: Silky Hamama; Lazaro Hamusikili, Oliver Kashembe, Kiverness Moono, Collins Moya, Gift Muchimba, Sylvester Munkonka, Sanigo Mwanza, Calisto Shankwasiya and many others.

The evolution, ecology and conservation of honeyguide-human mutualism

This project focuses on a unique mutualism: the foraging partnership between the Greater Honeyguide *Indicator indicator* and human honey-hunters whom it guides to bees' nests. Honeyguides know where bees' nests are located and like to eat beeswax; humans know how to subdue the bees using fire, and open nests using axes. By working together, the two species can overcome the bees' defences, with benefits to both. Remarkably, this relationship has evolved through natural selection, rather than through training or domestication which underpins cooperation by other human foraging partners such as dogs or falcons. The honeyguide-human system provides a wonderful opportunity to study the ecology and evolution of mutualisms in nature, because local human and honeyguide populations vary strikingly in whether and how they interact, and because we can readily manipulate these interactions experimentally.

Claire Spottiswoode and her team have been studying human-honeyguide interactions in the Niassa National Reserve of northern Mozambique since 2013, collaborating with the honey-hunting community of Mbamba village, and receiving crucial support from the Mariri Environmental Centre led by Dr Colleen and Keith Begg of the Niassa Carnivore Project. A key focus to date has been investigating reciprocal communication between the two parties: not only do honeyguides signal to humans, but in many different cultures humans signal back to honeyguides, giving special calls to attract honeyguides and maintain their attention while following them. Among the Yao honey-hunters of northern Mozambique, this call is a loud trill followed by a grunt: "brrrr-hm!". In 2016, using a field experiment, we showed that honeyguides were twice as likely to initiate a cooperative interaction with humans who made this sound compared to humans giving control human and animal sounds, and three times as likely to successfully lead such humans to honey. So honeyguides use these specialised signals to choose partners who are likely to be good collaborators, in a two-way conversation between humans and a wild animal, from which both partners benefit.

Supported by a Consolidator Grant from the European Research Council, we now ask whether learning is involved in maintaining a geographical mosaic of honeyguide adaptation to local human cultures; how such reciprocal communication between humans and honeyguides mediates their interactions; what the effects of cultural co-extinctions may be on each partner and their ecosystems; and ultimately, how quickly such cultures can be re-ignited following their loss. In so doing we hope to test for the first time the hypothesis that reciprocal learning can give rise to matching cultural traits between interacting species. Understanding the role of such phenotypic plasticity is crucial to explain how and why the outcome of species interactions varies in space and time, and to predict how they will respond to a rapidly changing world.

Our research has the support of the community and traditional chiefs of Mbamba and Nkuti Villages. Our project is known as 'Projecto Sego' (sego is greater honeyguide in the Yao language), and heavily involves the local community in independent data collection as well as assistance with our field sampling and experiments.

Activities in 2019

- From May to October MSc student David Lloyd-Jones and local data manager Orlando Ncuela provided ongoing training and support to 20 honey-hunters collecting data. This was enabled by a custom app we developed with HabitatInfo.
- From May to June, David carried out behavioural experiments to test if young honeyguides refine their guiding behaviour through learning.
- Also from May to June, Post-doc Jessica van der Wal studied geographic variation in human

Carvalho Issa Nanguar of the Projecto Sego team holding 'Red over Red'. Named for his colour rings, this male Greater Honeyguide has been captured almost annually since 2013. He is a very eager guide of human honey-hunters (Photo: Dominic Cram).

honey-hunting culture in collaboration with Celestino Dauda (Niassa Carnivore Project), supported by independent grants from the Association for the Study of Animal Behaviour and the American Ornithological Society.
- From August to October, Dominic Cram, Jessica and David colour-marked honeyguides and conducted experiments in our study area.
- We hosted an intern, Antonio Ngovene. Antonio is a student on the Conservation Biology MSc course at the Edward O. Wilson Biodiversity Laboratory, Gorongosa National Park.

Highlights

- Twenty Niassa community honey-hunters have collected high-quality data on hundreds of honey-hunting trips, involving thousands of interactions with honeyguides.
- In June, we celebrated our second year of honey-hunter data-collection with a 'Festa' at Mariri Environmental Centre, awarding prizes for data and photo quality and care of equipment.
- We have established a colour-ringed population of over 100 Greater Honeyguides, plus smaller numbers of Lesser and Scaly-throated Honeyguides (which eat wax but do not guide humans) in our study area.
- The research team carried out regular outreach activities in Mozambique, giving presentations to school learners from Niassa Province visiting the Mariri Environmental Centre, and sharing our research findings with the Niassa National Reserve management team.
- We assisted a team from National Geographic magazine in the field.
- Dominic Cram was awarded an Early Career Grant by the British Ecological Society.
- Claire presented recent highlights of our honeyguide research at the 'Frontiers in Behavioural Research' symposium at the Max Planck Institute for Ornithology, Seewiesen, Germany.
- David presented a talk on honeyguides guiding humans to dangerous animals at the TAWIRI Research Conference in Arusha, Tanzania.

Impact of the project

This project involves rural communities in understanding a unique human-animal relationship. We hope to further our understanding of how mutualisms evolve, and specifically how learnt traits mediating mutualisms may coevolve with one another. Understanding the evolution of mutualisms is important because it sheds light on the mechanisms that can maintain cooperation among unrelated individuals. It is also important for effective conservation, because mutualisms can have a wide reach in ecological communities. The honeyguide-human mutualism has already died out from large parts of Africa, as the continent develops. It would be a tragedy if it vanished altogether before we fully understood this part of our own evolutionary history.

Key co-supporters

European Research Council; National Geographic Society; Max Planck Institute for Evolutionary Anthropology; DST-NRF CoE grant; British Ecological Society; Association for the Study of Animal Behaviour; American Ornithological Society.

Research team 2019

Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
Dr Jessica van der Wal (FIAO, UCT)
Orlando Ncuela (Niassa Carnivore Project)
Dr Dominic Cram (U. Cambridge)
Dr Brian Wood (U. California Los Angeles)
Prof. Timm Hoffman (Biological Sciences, UCT)
Dr Colleen Begg (Niassa Carnivore Project)
Keith Begg (Niassa Carnivore Project)

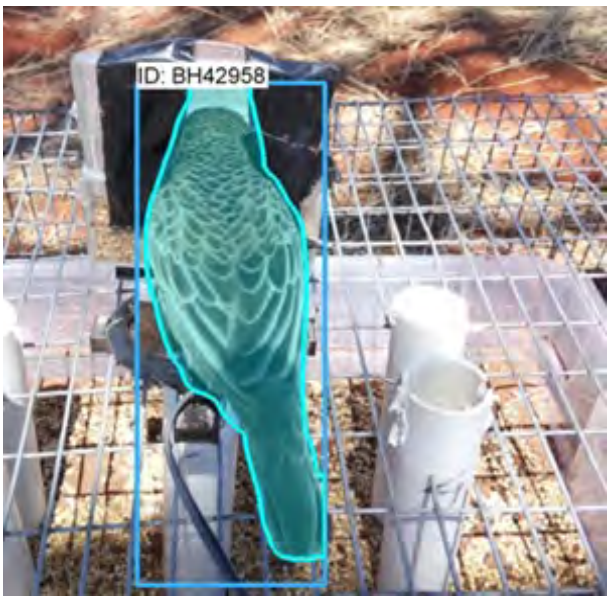
Student: David Lloyd-Jones (MSc, UCT)

Research Assistants: Musaji Muemede, Carvalho Issa Nanguar, Iahaia Buanachique, and Seliano Alberto Rucunua, with data collection by many others.

Cooperation and population dynamics in the Sociable Weaver

The aptly named Sociable Weaver *Philetairus socius* is a highly social species that is endemic to the Kalahari region of southern African. As the common name suggests, these weavers work together to accomplish diverse tasks, from building their highly distinctive thatched nests to help raising the chicks and defending the nest and colony mates from predators. Their fascinating social structure and different types of cooperative behaviour make them an ideal study model to investigate the benefits and costs of sociality and the evolutionary mechanisms that allow cooperation to evolve and be maintained.

Cooperation represents an evolutionary puzzle because natural selection is thought to favour selfish individuals over co-operators. However, theory and studies in humans suggest that co-operators are preferred as social and sexual partners. Partner choice may therefore provide a powerful explanation for the evolution and stability of cooperation, alongside kin selection and self-serving benefits, but we lack an understanding of its importance in natural systems. This has become an important focus of the Sociable Weaver project, led by Rita Covas and Claire Doutrelant, and a recent grant from the European Research Council (ERC) will allow us to focus on this topic over the next five years by using new methodological developments to implement automatic data collection of cooperative behaviour and run field experiments.



A new technique based on artificial intelligence now allows us to identify individual birds based on the unique pattern of their feathers. This is being used to collect larger volumes of data on cooperative behaviours such as nest building and predator vigilance (Photo: André Ferreira).

The sustained funding is also crucial to continue our long-term study of the costs and benefits of sociality and weaver population trends. In particular, under the current scenario of increasing environmental variation, we are attempting to establish whether sociality may lessen the impacts of these adverse conditions.

Activities in 2019

- 2019 was another record year, with late rains and high temperatures resulting in a very late onset of breeding (February instead of September). The late rains led to a long breeding season that continued until July and a very short winter break. By the end of August, the birds were starting to breed again! As a result, almost 500 chicks had fledged by the end of December 2019! The Sociable Weaver is an opportunistic breeder and the increasing unpredictability of climate patterns is causing increasingly irregular breeding seasons.
- Keeping track of all the individuals in our population and collecting the behavioural data needed to test different hypotheses has represented a challenge that we have been attempting to address in creative ways. Over the last year, PhD student André Ferreira developed a method that uses artificial intelligence to identify individual Sociable Weavers based on the feather patterns on the individuals' back allowing us to speed up data collection and analyses. This method is already being applied to the study of nest building behaviour in our population and we intend to apply it also to the study of vigilance and mobbing behaviour.
- One of the advantages of long-term studies is to

be able to monitor how individuals adapt to the variation in their environment over several years. PhD student Rita Fortuna analysed an 8-year data set to investigate whether female Sociable Weavers vary their reproductive investment to match the variation in ecological and social factors. The results revealed that females are highly consistent in the size of their eggs, but clutch size varies in relation to rainfall.

- Another analysis of long-term data by BSc Hons student Delphine Duval suggests that infanticide increases under adverse climactic conditions.
- A collaboration with researchers at the CNRS and University of Strasbourg (France) allowed us to investigate whether physiological benefits arise from the presence of helpers. Using a cross-fostering experiment, PhD student Martin Quque analysed telomere length in nestlings in relation to the presence of helpers during egg production and the nestling stage. Chicks receiving additional care of postnatal helpers had longer telomeres than chicks that never had helpers, and chicks with longer telomeres at day 9 were more likely to survive. However, this result was not maintained at fledging.
- Unlike most other birds, Sociable Weavers are sexually monogamous and most individuals pair for life. Post-doc Pietro D'Amelio has been investigating the benefits of these long-term associations and found that individuals that have been together for longer start to breed earlier in the season and continue until later, and as a result fledge more chicks.
- Pietro also concluded an experiment to investigate whether male helpers are more cooperative in the presence of females by simulating the presence of different audiences using playbacks.

Highlights:

- Rita Covas received an ERC grant (EU) to study the role of partner choice on the evolution of cooperation.
- Claire Doutrelant received a French National Research Agency (ANR) grant to study the role of sexual and social selection in the evolution of nest building in Sociable Weavers.
- Rita and Claire published a paper in *Trends in Ecology and Evolution* about the role of sexual and social selection in cooperation.
- Former PhD student Dorine Jansen published a paper in *Population Ecology* which uses an integrated population model to illustrate the environmental factors influencing population dynamics in the Sociable Weaver.
- André Ferreira gave a talk at the ASAB conference in August (Konstanz, Germany) about a new method that uses artificial intelligence to identify small birds based on individual feather patterns. A manuscript describing this method is under review.
- MSc student António Vieira graduated from CIBIO, U. Porto with a project on the role of helpers on reproductive output.
- MSc student Louis Bliard, graduated through the European 'Darwin' programme with a project on the effects of group size on helper survival.
- A new student, Bruna Fonseca (CIBIO, U. Porto) joined the project to investigate the role of colony size on agonistic behaviour.

Impact of the project

The long-term nature of this project allows unique insights to understand the evolution of cooperation and the mechanisms that allow it to persist. The demographic data allow for examination of the factors affecting population dynamics in relation to environmental change.

Key co-supporters

The Foundation for Science and Technology (FCT), Portugal; French Research Agency; ANR, France; DST-NRF CoE grant.

Research team 2019

Dr Rita Covas (FIAO, UCT and CIBIO, U. Porto)
Dr Claire Doutrelant (FIAO, UCT and CNRS, France)
Dr Fanny Rybak (U. Paris-Sud, France)
Dr Pietro D'Amelio (FIAO)
Dr Julien Renoult (CEFE-CNRS, France)
Dr François Criscuolo (CNRS, Strasbourg, France)
Dr Damien Farine (Max Planck Institute, Germany)

Students: André Ferreira (PhD, Montpellier); Rita Fortuna (PhD, Porto); Martin Quque (PhD, Strasbourg); Louis Bliard (MSc, Montpellier); António Vieira (MSc, CIBIO); Claire Shigo (Hons, Montpellier); Delphine Duval (Hons, Montpellier).

Research Assistants: Franck Théron, Liliana Silva, Cécile Vansteenberghe, Jess Berndt, Colleen Lindberg, Baudoin des Monstiers, Michelle Schroeder, Corisande Abiven, Annick Lucas, Samuel Perret.

Pied Babblers and Fork-tailed Drongos

Tim Clutton-Brock established the Kuruman River Reserve to study group living in meerkats, but it has become the focus of several other long-running animal studies: Amanda Ridley started habituating Southern Pied Babblers *Turdoides bicolor* in 2003 to understand the causes and consequences of cooperative breeding. In 2006 she started to investigate the interactions between Fork-tailed Drongos *Dicrurus adsimilis*, babblers and other species. Tom Flower joined the Drongo Project in 2008 to study the drongos' use of false alarm calls to steal food from other animals. Recently, Amanda and Tom have collaborated with Susie Cunningham to explore how increasing temperatures will affect the demography of these species in marginal desert environments.

The causes of conflict and cooperation in group-living societies

The Pied Babbler research project investigates the costs and benefits of cooperation in this group-living species. Long-term life history data, along with short-term observations and experiments, have helped us understand the causes and consequences of cooperative breeding behaviour. Group sizes vary according to weather conditions, with the population decreasing when breeding seasons are hot and dry, and during very cold winters.

The range of questions that can be asked increases as the duration of the study grows, and we can now assess life-time fitness. PhD student Amanda Bourne is using the long-term database to understand the impact of heatwaves and drought on survival and reproductive success. We are also investigating the impact of heat on cognitive ability, because cognition is vital to an individual's ability to behaviourally respond to changes in their environment. PhD student Camilla Soravia' is studying the ontogeny of cognition and the relationship between cognition and sociality.

How interactions between species shape animal behaviour

The Fork-tailed Drongo project explores how interactions with other species can shape the evolution of behaviour. Over 40 pairs of individually colour-banded drongos have been habituated. Current research considers the cognitive mechanisms that enable drongos to produce false alarm calls and adjust the calls they use depending upon feedback from the target species. Since 2014, we also have studied the impact of climate change on bird persistence in hot desert environments through impacts on foraging behaviour and offspring provisioning. PhD student Ben Murphy is studying how drongos adjust their behaviour to reduce the impact of high temperatures on reproductive success, including through offspring shading, foraging tactics and crepuscular/nocturnal activity. Such behaviour change may compensate for the costs of missed opportunities when temperatures are high, enabling drongos to adapt to climate change. However, it remains to be determined whether the behavioural adjustments are sufficient to enable drongos to persist in their current range.

Activities in 2019

- PhD student Amanda Bourne completed her fieldwork on Pied Babbler behaviour and physiology. Amanda worked incredibly hard for three field seasons and collected a tremendous amount of behavioural, demographic and physiological data.
- Research assistant Sanjo Rose, together with PhD student Amanda Bourne, research assistant Lesedi Moagi, and Susie Cunningham mapped the home ranges of ten babbler groups and conducted a field survey to understand vegetation and microsite structure in these home ranges. These data are now being used to assess what constitutes a "high quality" babbler territory.
- PhD student Camilla Soravia started her research on the relationship between heat stress and cognitive performance, testing the hypothesis that increased heat stress leads to cognitive

Amanda Bourne prepares to weigh a group of Southern Pied Babblers, which have been habituated to stand on a top pan balance in return for a small food reward. In 2019 Amanda completed the fieldwork for her PhD looking at interactions between temperature and group size in these cooperatively breeding birds (Photo: Halcyone Muller).

impairment, and hence a limited ability to respond to stimuli in their surrounding environment.

- Martha Nelson-Flower and Amanda Ridley completed a book chapter for a new edited book on Cooperation and Conflict.
- PhD student Ben Murphy made good progress during his first field season and is presently completing his second field season.

Highlights:

- Two papers on Pied Babblers were published in 2019. The first, by PhD student Amanda Bourne, validated a non-invasive technique for monitoring metabolism in free-ranging birds and was published in *Functional Ecology*. The second, by Prof. Andrew McKechnie's Honours student Emma Jepsen, conducted non-invasive monitoring of stress in wild Pied Babblers by using faecal samples, and was published in *General and Comparative Endocrinology*.
- Pied Babbler and Fork-tailed Drongo research was presented at several national and international conferences, including the Australasian Ornithological Conference.
- Dr Tom Flower was promoted to a full-time tenured Lecturer position at Capilano University, British Columbia, Canada.
- Tom joined the Executive Board of the Wild Bird Trust of British Columbia.

For more details on the collaborative work between the Pied Babbler and Fork-tailed Drongo Projects and the Hot Birds Research Project, see page 45.

Key co-supporters

DST-NRF CoE grant; Australian Research Council

Research team 2019

A/Prof. Amanda Ridley (FIAO, UCT / UWA)
Dr Thomas Flower (FIAO, UCT / Capilano University)
Dr Martha Nelson-Flower (Langara College)
Dr Susie Cunningham (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
Prof. Andrew McKechnie (UP)

Students: Amanda Bourne (PhD, UCT); Ben Murphy (PhD, UCT); Camilla Soravia (PhD, UWA).

Research Assistants: Grace Blackburn, Lesedi Moagi, Lena Pina Ramirez, Sanjo Rose.

Sociable Weaver nests as a resource

This project examines the importance of Sociable Weaver *Philetarius socius* nests to Kalahari animal and plant communities. The objectives are to investigate the diversity of animals associated with the nests, the interactions between these species, and to gain insights into the life histories of associated species. We also aim to understand how the 'ecological engineer' potential of these nests may have community-wide impacts on structure and function, and how this impact may change across environmental gradients.

Evidence of the importance of facilitation in communities has accumulated, which challenges traditional emphasis of negative interactions in ecology. In particular, facilitative interactions are predicted to increase in importance in stressful environments and may become a crucial component of the adaptive responses of communities under stress. Ecological engineers – species that modify habitats and ameliorate abiotic stress for other species – are a key research focus. Identifying and understanding the impact of ecological engineers is vital, especially in arid environments that are expected to become harsher with global climate change.

Pygmy Falcons *Polihierax semitorquatus* are the most controversial user of the weaver colonies. They never construct their own nests, depending entirely on weaver colonies, which is a unique obligate nesting association. Pygmy Falcons also, albeit rarely, prey on weaver nestlings and even adults, suggesting a semi-parasitic relationship between the species. We aim to describe the natural history and ecology of Pygmy Falcons, and to characterize their interactions with Sociable Weavers; do falcons provide benefits to weavers or are they vertebrate parasites?

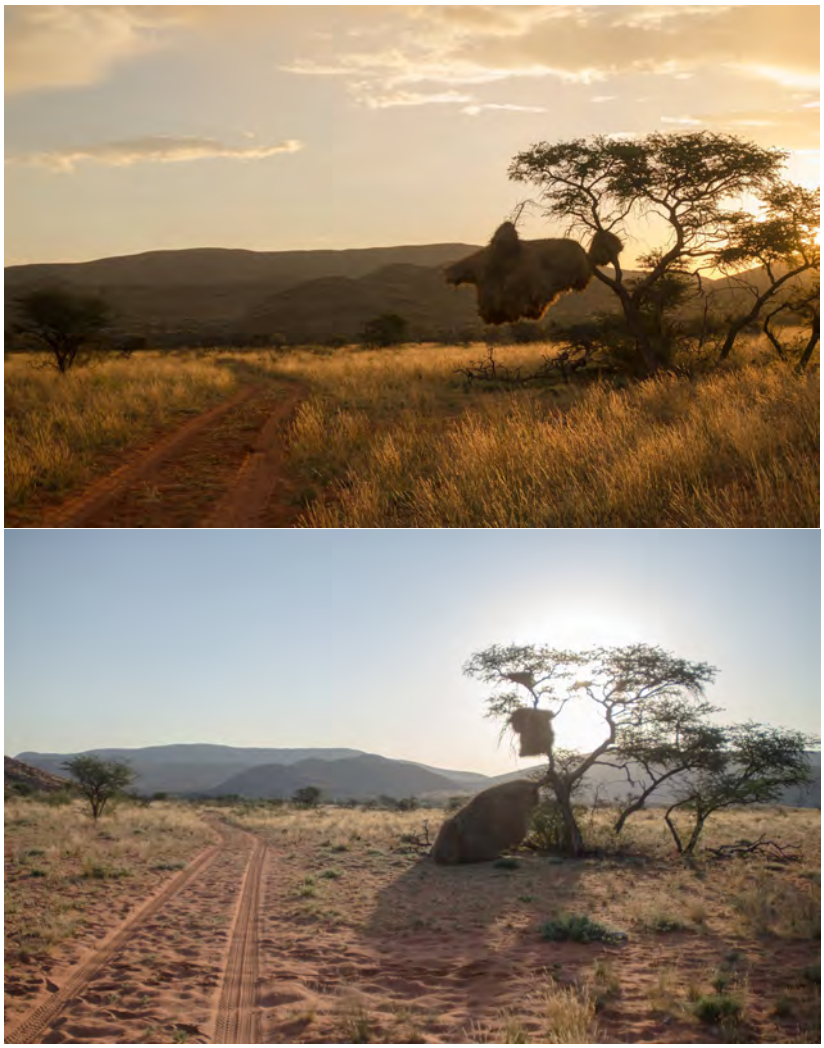
Pygmy Falcons frequently prey on Kalahari Tree Skinks, an arboreal lizard that associates with Sociable Weaver colonies. Anthony Lowney has shown that the tree skinks use the weavers as an early warning system, cueing on alarm calls and escape flights to decrease the risk of falcon predation (Photo: Anthony Lowney).

Activities in 2019

- Two new PhD students, Olufemi Olubodun and Timothy Aikins Khan, started in the project in the second half of 2019. Olufemi is investigating various aspects of the life history of African pygmy falcons. Timothy is investigating the costs and benefits to Camelthorn *Vachellia erioloba* and Shepherd's trees *Boscia albitrunca* from hosting Sociable Weaver colonies.
- The project hosted the field camp of the Fitz's Conservation Biology Master's programme. Thirteen MSc CB students spent a week at Tswalu Reserve in the Kalahari where they collected a range of data related to the impacts of Sociable Weaver colonies on plant and animal communities.
- The Pygmy Falcon population in the study area was followed for the ninth season. Olufemi has been monitoring their breeding success and group compositions.
- Data collection towards the KEEP (Kalahari Endangered Ecosystem Project) collaboration with WITS, UP, UNISA and UWC researchers started in earnest. These long-term data will contribute to identifying the impacts of climate change on the Kalahari ecosystem.
- Our team presented the results of our studies at one international and one national conference.

Highlights:

- We published an article entitled 'Helpers improve fledgling body condition in bigger broods of cooperatively breeding African Pygmy



There are costs and benefits to trees of hosting Sociable Weaver colonies. Timothy Khan Aikins is measuring the benefits in terms of nutrient input by the weavers and the use of these nutrients by both Camelthorn and Shepherd's trees. The costs are being measured in terms of lost canopy area, branch breakage and other physical damage. Timothy is focusing on trees hosting colonies that are different in size which might be key to the net outcome of the cost-benefit trade-off (Photos: Anthony Lowney).

Falcon' in *Behavioural Ecology and Sociobiology* with Diana Bolopo as first author.

- Jess Lund's BSc Hons thesis investigating winter thermoregulation in free-ranging Pygmy Falcons won the award for best UCT Biological Sciences dissertation in 2018.
- Anthony Lowney submitted his PhD thesis and is currently awaiting the evaluation of the reviewers.
- Robert Thomson and Diana Bolopo presented papers at the European Ornithological Union Conference in Romania.
- Anthony Lowney presented a paper at the 10th Oppenheimer Conference in Johannesburg.

Impact of the project

This project is providing unique insights into the community ecology and between-species interactions in the Kalahari. It will quantify the ecological engineering role of the Sociable Weaver and potentially determine the role of Sociable Weaver nests in a warming and increasingly arid Kalahari. The outputs of this project will also contribute to available eco-tourism information that enhances the experience of visitors to landscapes within the distribution of the Sociable Weaver.

Key co-supporters

DST-NRF CoE grant; Tswalu Foundation; University of Cape Town launching grant, Suzuki South Africa.

Research team 2019

Dr Robert Thomson (FIAO, UCT)
Dr Diana Bolopo (FIAO, UCT)
Prof. Michael Cramer (Biological Sciences, UCT)
Prof. Andrew McKechnie (UP)
Dr Luke Arnot (UP)
Dr Dorianne Elliott (UP)
Billi Krochuk (UBC)

Students: Timothy Aikins Khan (PhD, UCT); Anthony Lowney (PhD, UCT); Olufemi Olubodun (PhD, UCT).

Research Assistant: Rion Cuthill.

Understanding colour polymorphism in birds

Many species show a variety of different phenotypes. How such diversity is maintained is one of the main questions in evolutionary biology. Colour polymorphism represents an ideal system to explore these issues because the different phenotypes represent their genotypes. Researchers have long been fascinated by colour polymorphism because the occurrence of two or more phenotypes in the same population runs counter to the notion that selective pressure should favour the optimal form for an environment, and any lesser quality individuals should be eliminated through natural selection. Colour polymorphism occurs in around 3.5% of bird species, but is more common in raptors and particularly within *Accipiter* hawks where about 25% of species are polymorphic.

Colour morphs influence the performance and fitness of individuals through direct effects of pigment production (e.g. camouflage or thermoregulation) and indirect effects (e.g. physiological and behavioural traits). Hence, it is unlikely that different morphs are distributed randomly in the environment. Our focus species is the Black Sparrowhawk *Accipiter melanoleucus*, which occurs as either a dark or a light adult morph. The morph distribution of this species across South Africa follows a cline associated with rainfall seasonality and the intensity of solar radiation, with a far higher proportion of dark morphs in the Western Cape than the rest of the country. Our research has shown that provisioning rates differ depending on ambient light levels, with dark morphs providing more food to their chicks in duller light conditions than the light morph, possibly due to improved background crypsis. Thus, when the two morphs breed together in a 'mixed' pair, they might complement each other by expanding the conditions (daylight hour, prey or habitat types) in which parents can forage successfully. Indeed, pairs consisting of mixed-morph parents produce more offspring than parents of the same morph, and their offspring show higher survival rates. The idea that pairs consisting of the two morphs may complement each other has been termed the complementarity hypothesis.

We have extended the project from correlative studies to conducting field experiments and behavioural tests under laboratory conditions to understand the mechanisms underpinning the fitness advantages for breeding with a partner of the opposite morph. We are also developing an Integral Projection Model (IPM) to understand the different components of the system.

A 4-week old Black Sparrowhawk chick during a ringing procedure. Body morphometric measurements and feather and blood samples are taken to allow us to draw conclusions about colour polymorphism maintenance and the influence of urban stressors. A unique colour ring combination will make this individual identifiable for the rest of its life (Photo: Mayur Prag).

Additional research has focused on the genetics behind plumage polymorphism. In many avian and non-avian species discrete colour polymorphisms have been linked to the coding region of *MC1R*, a gene involved in the regulation of melanin production. However, we have established that this is not the case for Black Sparrowhawks. Several other potential candidate genes also have been excluded. Our research suggests that the differences in melanin production characteristic of the two morphs in this species is associated with different regulation

of key genes involved in melanin production. Interestingly, variation in pheomelanic plumage in juveniles appears to be regulated by differences in expression of the same genes. We are now testing for differences in telomere dynamics between the two adult morphs to determine if there are any pleiotropic effects of morph. We also have developed an assay to quantify haemosporidian blood parasite prevalence and intensity from blood samples using qPCR, which we are using to supplement microscopy data to assess morph specific differences in blood parasite prevalence and intensity in the species.

Activities in 2019

- We performed an immune challenge on 23 Black Sparrowhawk chicks from 15 nests to understand the strength of the innate immune function in relation to parental morphs.
- We initiated a collaboration with Dr Dylan Childs (U. Sheffield) using Integral Projection Models. Dr Childs visited UCT in September, funded by UCT's Visiting Scholars Fund and a Royal Society International Exchange grant.
- PhD student Carina Nebel visited Lund University to analyse blood samples. Data on the innate immune system and oxidative stress levels will be related to parental morph combinations and urban stressors.
- PhD student Ed Rodseth quantified the expression of six candidate genes in developing feather tissue from adult and juvenile Black Sparrowhawks to characterise different regulation genes involved in melanin production. Ed measured melanin levels using HPLC and linked differences in melanin production to expression of the candidate genes.
- We measured relative telomere length in adults using qPCR to determine if we can detect pleitropic effects of morph and developed a qPCR based assay to quantify haemosporidian prevalence and intensity from adult blood samples.

Highlights

- Dr Chima Nwaogu joined the research group in March. Part of his research will explore timing of Black Sparrowhawk breeding in relation to weather parameters and their colour morph.
- In collaboration with Dr Chevonne Reynolds (Wits) and Dr Chris Briggs (Hamilton College, USA), a paper was published in the *Biological Journal of the Linnean Society* on colour polymorphism in Swainson's Hawk *Buteo swainsoni*.
- In collaboration with Dr Alexandre Roulin and colleagues from Lausanne University, we published a paper in *Nature Ecology & Evolution* on Barn Owl *Tyto alba* hunting success under different phases of the Lunar cycle.
- Carina Nebel published her first PhD chapter as a paper in *Royal Society Open Science* in which she tested whether prey reaction times differed under varying environmental conditions and in relation to predator morph.
- In collaboration with Dr Josef Harl (Austria), a paper was published in *Parasitology Research* on blood parasites of Feral Pigeons *Columba livia,* which explored how the degree of melanism influences blood parasite intensity and prevalence.
- Petra Sumasgutner and Carina Nebel presented research from the project at the European Ornithologists' Union (EOU) in August 2019 in Cluj, Romania.

Impact of the project

This project will add to our understanding and theory about the maintenance of genetic diversity in populations. It provided the first empirical evidence for the light level hypothesis for the maintenance of colour polymorphism in birds that is now experimentally tested.

Key co-supporters

DST-NRF CoE grant, UCT Visiting Scholars Fund, Royal Society International Exchange Grant.

Research team 2019

A/Prof. Arjun Amar (FIAO, UCT)
Dr Petra Sumasgutner (FIAO, UCT)
Dr Chima Nwaogu (FIAO, UCT)
Dr Rob Ingle (MCB, UCT)
Dr Dylan Childs (University of Sheffield)
Dr Arne Hegemann (MEEL, Lund University)
Dr Gareth Tate (EWT)
Dr Jacqui Bishop (Biological Sciences, UCT)
Dr Chevonne Reynolds (Wits)
Dr Chris Briggs (Hamilton College, USA)

Students: Carina Nebel (PhD, UCT); Edmund Rodseth (PhD, MCB, UCT); Adrien Pajot (M.Eng, U. Bordeaux).

Research Assistants: Dr Shane McPherson, Burghen Siebert.

Volunteers: Ann Koeslag, Margaret MacIver, Antje and Bernard Madden.

Bird pollination in the Cape Floristic Region

Do anthropogenic effects change the ecosystem services provided by nectarivorous birds? The Cape Floristic Region hosts over 300 plant species that depend on only eight species of nectar-specialist birds (sunbirds and sugarbirds). This unusually asymmetrical mutualism provides an ideal system to investigate the pivotal role that pollinators play in the evolution and conservation of plants. Post-doc Anina Coetzee and MSc student Samantha McCarren are investigating how sunbirds influence flower colour evolution in bird-pollinated *Erica* species. Such processes may now be threatened by habitat fragmentation in many parts of the Cape Floristic Region, and understanding these effects is the goal of PhD student Daniël Cloete's research. At the border between urban and natural fragments, supplementary feeding, which is increasing in popularity, may impact sunbird-plant mutualisms. Monique du Plessis' MSc study will assess the effect of feeders on sunbirds and bird-pollinated *Erica* species.

The genus *Erica* is one of the most diverse in the fynbos biome, and its many bird-pollinated species are striking for the high levels of colour polymorphism in their flowers. Some *Erica* species have up to five colour morphs yet are pollinated predominantly by just one bird species, the Orange-breasted Sunbird *Anthobaphes violacea*. This project investigates the origin and maintenance of these flower colour polymorphisms. Specifically, we are asking what role plant community context and sunbird foraging behaviour play in generating intra-specific lower colour diversity.

African nectarivorous birds are thought to be able to detect ultra-violet (UV). Thus, UV colouration might be used by bird-pollinated flowers in the Cape Floristic Region to increase visibility for their pollinators. However, nectar-robbing insects might also use this channel for foraging decisions and consequently there may be selection against UV signals. Samantha McCarren is quantifying UV reflectance in bird-pollinated flowers in the Cape, and using choice experiments to test whether sunbirds or insects exhibit a preference for certain flowers based on their UV reflectance.

PhD student Daniël Cloete is working in and around the Tsitsikamma section of the Garden Route National Park to assess how habitat fragmentation affects the fitness of bird-pollinated plants. Daniël is testing whether certain thresholds of patch size and isolation exist where pollination services by birds start to break down. To do so, he is measuring pollination by sunbirds and Cape Sugarbirds *Promerops cafer* of *Protea* and *Erica* species across 17 fynbos patches, both natural and fragmented, in the Nature's Valley area. This is a good area to address this question because it naturally comprises of a mosaic of forest, fynbos and coastal thicket, further fragmented by agriculture, plantations, alien infestations, farmland and urban areas. Insights from Daniël's research will hopefully shed light on how threats, including land-use change, alien invasive vegetation and climate change might affect ecosystem function and services in the Cape Floristic Region.

Activities in 2019

- Post-doc Anina Coetzee completed pollination experiments on co-occurring *Erica* species, which showed that bird-pollinated *Erica* species are highly dependent on sunbirds for seed production and that hybridisation between species is limited by post-pollination isolation barriers.
- Anina's research was communicated to the public through an article in *African Birdlife* and presentations at bird clubs and museums.
- Samantha McCarren completed data collection on flower reflectance of a diversity of plant families, and choice experiments on sunbirds and insects to test their flower preferences.
- Monique du Plessis completed her first year of field experiments, during which she conducted seasonal bird surveys in 18 gardens and their

bordering fynbos veld. She alternated presence and absence of feeders between the gardens, comparing bird abundance of sites with and without feeders. In doing so, she will be able to test whether the presence of feeders attract nectarivorous birds away from the natural veld.

- Monique also measured *Erica* visitation rate in the bordering fynbos veld. She collected visitation rate data at varying distances from gardens to test whether the presence of feeders affects bird visitation pattern, potentially decreasing *Erica* pollination.
- Daniël Cloete completed his data processing and analysis following a year of fieldwork in the Nature's Valley area, where he collected data on bird species presence and relative abundance, *Protea* flowering phenology, and bird-pollinated *Protea* and *Erica* nectar traits and seed set.
- Daniël extracted data from his high-resolution aerial photos captured by drone to determine the distribution and density of bird-pollinated Protea species in each of the study patches.
- Daniël's preliminary analyses suggest that the fynbos-specialist endemics, Cape Sugarbird and Orange-breasted Sunbird, are both negatively affected by fragmentation. By contrast, more generalist species such as the Southern *Cinnyris chalybeus* and Greater Double-collared Sunbirds *C. afer* and Amethyst Sunbirds *Chalcomitra amethystina* are more accepting of fragmentation, and may even benefit because of their flexibility to use resources from the surrounding non-fynbos matrix.

Highlights

- Anina presented her research results at the European Society for Evolutionary Biology in Turku, Finland, and at an *Erica* Symposium in Cape Town.
- Monique was awarded a competitive Joan Wrench Scholarship from SANBI for her MSc study.

Impact of the project

The unique sunbird-*Erica* mutualism will allow us to gain insights into the mechanisms by which bird behaviour affects community ecology. It provides an opportunity to address knowledge gaps, particularly because human disturbance may directly interact with evolutionary processes in this system. Insights into the effects of habitat transformation and supplementary feeding on pollination systems such as this will inform the development of guidelines for maintaining biodiversity and ecosystem functioning.

Field assistants Rion Cuthill and Rhiannon Gill set up artificial nectar feeders in a Simon's Town garden (Photo: Monique du Plessis).

Key co-supporters

DST-NRF CoE grant; Claude Leon Foundation, The Botanical Education Trust; Biotechnology and Biological Sciences Research Council; South African National Botanical Institute; Joan Wrench Scholarship, Harry Crossley GreenMatter Scholarship.

Research team 2019

Dr Anina Coetzee (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
Dr Colleen Seymour (SANBI, FIAO)
Dr Phoebe Barnard (FIAO, UCT)
Dr Mark Brown (Nature's Valley Trust)
Prof. Peter Ryan (FIAO, UCT)
Prof. Jeremy Midgley (Biological Sciences, UCT)

Students: Daniël Cloete (PhD, UCT); Monique du Plessis (MSc, UCT); Samantha McCarren (MSc, UCT)

Research Assistants: Rion Cuthill, Rhiannon Gill.

Intra-African bird migration

Migrant birds are at greater risk of extinction globally than are resident species. To date, most emphasis gloablly has been on long-distance, inter-continental migrants – and indeed populations of many of these species are decreasing rapidly due to human impacts across their migratory ranges. This project, started in 2015, used a broad-scale spatial approach to address questions of phylogeography, movement ecology, phenotypic and genetic variation in intra-African migrant birds that have seasonal breeding ranges across western, eastern and southern Africa.

Little is known about the migratory routes, timing, drivers, connectivity and environmental prescriptions of intra-continental migrant birds in Africa compared to inter-continental migrants. This project was initiated by Dr Phoebe Barnard, who recruited post-doc Dayo Osinubi, to investigate the migratory patterns of focal intra-African migrant birds. The main focus has been on Woodland Kingfishers *Halcyon senegalensis*, which have been sampled at three main sites throughout their range, but additional data have been collected on African Pygmy Kingfishers *Ispidina picta*, and Diederik *Chrysococcyx caprius* and Klaas's *C. klaas* Cuckoos.

Abigail Ramudzuli examines skins of Woodland and African Pygmy Kingfishers (Photo: Dayo Osinubi).

Activities in 2019

- After the fourth southern African field season in January 2019, Dayo Osinubi resigned his postdoctoral fellowship to take up a position with BirdLife International as the Conservation Programme Coordinator – Africa, based in Accra, Ghana. Dayo will use his new position to link the project to broader flyway conservation actions, and work in his spare time to publish the research conducted over the last four years.
- Abigail Ramudzuli completed work on her MSc project to explore moult patterns of Woodland Kingfishers and the use of stable isotope markers in their flight feathers, with a view to determining whether stable isotopes can indicate where migratory birds spend the non-breeding season. She will submit her thesis in early 2020.

Highlights

- Four geolocators deployed on Woodland Kingfishers breeding in northern South Africa have been retrieved from the 28 deployed over three years. A follow-up field season is planned for December 2020 to try to recover more loggers. However, with the support of Vogelwarte (the Swiss Ornithological Institute) the data on all four geolocators have been downloaded and are being analysed to identify the migration routes, timing and stop-over sites.

A Woodland Kingfisher inspects a nest box (Photo: Dayo Osinubi).

- Several papers are being developed for presentation at the 15th Pan-African Ornithological Congress to be held in Zimbabwe in November 2020.

Impact of the project

This project addresses some of the research, conservation and policy gaps concerning intra-African migrant birds. It also facilitates a research network that links research institutions across Africa, providing a near-regional operating base for other students and researchers to utilise in answering diverse questions about intra-African migrant birds. This network serves to support the objectives of the UNEP/CMS African-Eurasian Migratory Land-birds Action Plan (AEMLAP) and the Migrant Landbird Study Group (MLSG).

Key co-supporters

DST-NRF CoE grant; National Zoological Gardens of South Africa (NZG); International Foundation for Science; BirdLife International; A.P. Leventis Ornithological Research Institute; Swiss Ornithological Institute (Vogelwarte), African Bird Club, British Ecological Society; iThemba LABS.

Research team 2019

Dr Samuel Temidayo Osinubi (FIAO, UCT)
Prof. Desire Dalton (NZG)
Dr Phoebe Barnard (FIAO, UCT)
Prof. Peter Ryan (FIAO, UCT)

Student: Abigail Ramudzuli (MSc, UCT).

Evolution in island birds and the 'insularity' syndrome

Islands are important centres of endemism and key 'laboratories' for the study of ecology and evolution. However, some aspects of island ecology and evolution remain poorly understood. This programme studies patterns of adaptation and speciation on islands worldwide and conducts detailed studies using the Gulf of Guinea, Cape Verde and Tristan islands as study systems.

The Theory of Island Biogeography, which predicts how species richness on an island is a function of its size and isolation, remains one of the most elegant of ecological theories. Although the theory's architects, MacArthur and Wilson, were aware of the importance of speciation after colonisation, they were unable to include this variable in the model. In a project led by Luis Valente, we addressed this lack. By comparing sequences from almost 600 island birds from 41 archipelagos with those of their mainland relatives, we were able to estimate colonisation times and speciation rates. Amazingly, the empirical shape of the relationships between colonisation, extinction and speciation with island area and isolation is best explained by the original island biogeography model. With these results to be published in early 2020, we have initiated a pilot project to investigate communities from continental islands (i.e. those that were formerly linked to the mainland), starting with a sampling expedition to Bioko in the Gulf of Guinea in February 2020.

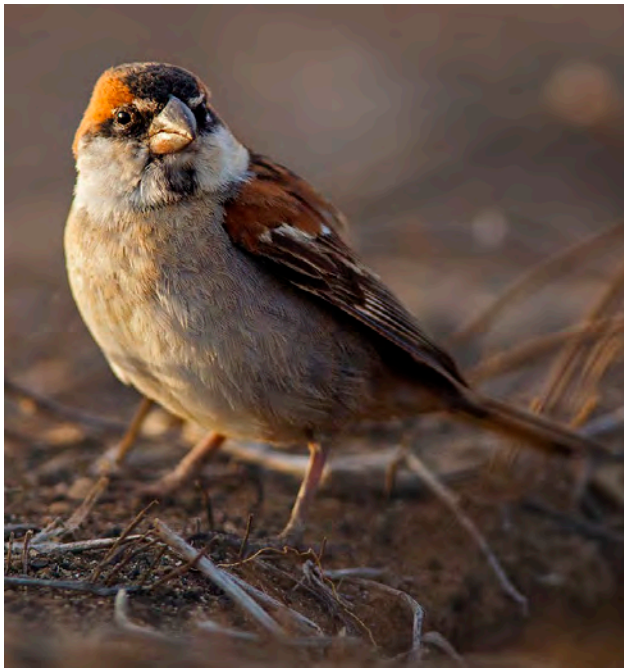
The Iago Sparrow *Passer iagoensis* occurs on most islands of the Cape Verde archipelago, and Martim Melo initiated a study of its adaptation to aridity. Long considered part of the Great Sparrow *P. motitensis* superspecies, genetic evidence places it sister to the Dead Sea *P. moabiticus* and Golden *P. luteus* Sparrows. Neutral genetic data from sparrows across all islands, obtained by RAD-sequencing in Rauri Bowie's lab, are being combined with full genome data from Mark Ravinet's lab to understand the links between environment, phenotype and genotype.

Islands typically have impoverished communities, and our previous work confirmed that this extends to parasite diversity. Low parasite levels could lead to weaker immune systems, as suggested by the extinction of many Hawaiian birds after the accidental introduction of a malaria vector. This hypothesis is currently being studied through a collaboration between Claire Doutrelant, Rita Covas, Martim Melo, Claire Loiseau and Benoit Nabholz, which is investigating the genes underlying specific types of immune response. Parasite diversity might increase in human-altered environments, so another study is investigating whether land-use practices influence avian parasites on São Tomé. Entomologists are documenting changes in the community of parasite vectors, a critical but often overlooked piece of this puzzle.

Activities in 2019

- Fieldwork on Príncipe Island found that the newly-discovered species of scops owl is fairly common in low-lying native forests, but has a small total range of only c. 30 km^2. Visits were made to the British, Dresden and Frankfurt museums to complete the new species' description.
- A survey along a gradient of human disturbance on São Tomé was conducted sampling birds, their parasites and parasite vectors, to assess the impact of human activities on bird-parasite interactions.
- Iago Sparrows: RAD-sequencing of 339 sparrows, and full genome sequencing of 23 Iago, 10 House and 10 Spanish Sparrows.
- Full genome sequences constructed for several São Tomé endemic birds and their mainland counterparts will be used to investigate whether insularity influences the evolution of the immune system by studying toll-like receptors.
- PhD student Alois Robert (U. Montpellier) showed that impoverished bird and insect communities affect the way birds sing on islands. MSc student, Louis Bliard (U. Montpelier) showed that impoverished predator communities affect plumage colour of island birds.
- Genomic data from Tristan's *Nesospiza* finches collated by Bengt Hansson (Lund U.) and Martin

Stervander (U. Oregon) have provided novel insights into this very recent adaptive radiation.



The Iago Sparrow (male shown here) is endemic to Cape Verde where it was first collected by Charles Darwin. It is an excellent model species for the study of speciation and adaptation (Photo: Alexandre Vaz).

A willing study model. A female Iago Sparrow explores the fruit bowl in the researcher's tent on Raso Islet (Photo: Martim Melo).

Highlights:

- Aloïs Robert was awarded a PhD for his work on the influence of community structure on acoustic signals in island birds. His paper on vocal differences between island and mainland birds was published in *Journal of Biogeography* and a second paper is in review.
- Louis Bliard received an MSc for his research on the role of avian predators in influencing the evolution of bird colouration on islands.
- Bárbara Freitas received an MSc degree for her work on the genetics and ecology of the newly discovered Princípe Island Scops-owl.
- A worldwide empirical analysis on colonisation times and speciation rates of oceanic island birds confirmed that MacArthur's and Wilson's Theory of Island Biogeography is robust to the inclusion of evolution in the process of the assembly of island communities.

Impact of the project

This project is uncovering novel patterns of adaptation in island birds and investigating the mechanisms underlying these adaptations. The results make a significant contribution to our understanding of the ecology and evolution of island environments. Given the large number of species endemic to islands worldwide and the threats to these faunas, our work will help to understand and conserve island species.

Key co-supporters

Forever Principe, National Geographic, CNRS (PEPS), University of Montpellier (PhD grant to Alois Robert), LIA Biodiversity, Portuguese Science and Technology Foundation.

Research team 2019

Dr Martim Melo (FIAO and CIBIO, U. Porto)
Dr Claire Doutrelant (CNRS and FIAO)
Dr Rita Covas (FIAO and CIBIO, U. Porto)
Dr Claire Loiseau (CIBIO, U. Porto)
Dr Mark Ravinet (U. Nottingham)
Dr Martin Stervander (U. Oregon)
Dr Luis Valente (Naturalis Biodiversity Center, Leiden)
Prof. Rauri Bowie (U. California Berkeley)
Prof. Bengt Hansson (Lund U.)
Prof. Peter Ryan (FIAO)

Students: Sandra Reis (PhD, CIBIO, U. Porto); Aloïs Robert (PhD, CNRS and U. Montpellier); Bárbara Freitas (MSc, CIBIO, U. Porto); Louis Bliard (MSc, CNRS and U. Montpellier).

Smart beaks – non-visual senses in birds

Most birds have excellent vision. This is part of what makes birds such an appealing group to study. However birds navigate their world using different senses as well. In this project, we investigate the non-visual senses of birds with a focus on tactile senses in their beaks. The main theme of the project is to understand the links between bill-tip anatomy and foraging ecology of three species of southern African ibises: Hadeda Ibis *Bostrychia hagedash*, Sacred Ibis *Threskiornis aethiopicus* and Glossy Ibis *Plegadis falcinellus*. These species all have a honeycomb pattern of pitting in the bones of the bill tips which suggests they should be able to forage using the sixth sense "remote touch": detection of small vibrations made by prey as they burrow or swim through the foraging substrate (soil, mud or water).

Carla du Toit started this project as an MSc student at the beginning of 2017, and upgraded to a PhD at the start of 2018. Carla's research focuses on the anatomy of the bill-tip organ in probe-foraging birds, including modern ibises and extinct species in the paleontological record. The bill-tip organ of probe-foraging birds is made up of mechano-sensory receptors embedded in densely clustered pits in the bone at the tip of the bill. Although the general structure of the bill-tip organ is similar across all probe foraging species that possess it, there is interspecific variation in the shape and orientation of the pits and the receptors within them. The overall aim of Carla's thesis is to use ibises as a model to investigate the link between the morphology of the bill-tip organ and the birds' foraging ecology, and to explore whether these patterns can be extrapolated to infer information about the foraging ecology of extinct bird species.

The strong link between the morphology of the bony parts of the bill-tip organ and foraging behaviour suggests that we can use the structure of fossil beaks to infer information about the palaeoecology of extinct birds. In 2019, Carla undertook an extensive review of the bone structures of the beaks of over 500 species from all orders of extant birds. The review will allow us to establish whether we can determine the presence of a remote-touch-capable bill-tip organ in modern birds, based solely on the structures found on their beak bones. Furthermore, based on the phylogenetic position of some of the fossil specimens that Carla is studying, we may be able to make some significant conclusions about the foraging ecology of some of the most basal members of the avian family tree, shedding light on some contentious questions regarding the evolution of modern birds.

A Hadeda Ibis foraging in an experimental tray at the World of Birds (Photo: Carla du Toit).

Activities in 2019

- Towards the end of 2019, Carla commenced training of captive Hadeda Ibises at the World of Birds in Hout Bay, habituating the birds to probe in soil-filled trays containing desirable (to ibises at least) superworms. This will allow her to investigate the functioning of the bill-tip organ under different substrate conditions. Her experiments are still underway and will allow us to gain detailed information on the use of remote-touch by Hadedas, and to determine to what extent their foraging success is affected by the levels of soil water, which will potentially lead to a better understanding of the recent

Carla du Toit setting up her experimental trays at the World of Birds. The fences allow the hadedas to access the trays but discourage them from interfering with each other during foraging trials. Two birds are eagerly awaiting the start of the experiment (Photo: Susie Cunningham).

range expansion of Hadedas across southern Africa.

- Carla attended two conferences in 2019: in July she presented the results of her field work with wild ibises as a speed talk at the meeting of the Zoological Society of South Africa. In August, she presented some of her preliminary results on the link between the soft tissue histology and surface microstructure of the beak bones in modern birds at the International Symposium for Palaeohistology in Cape Town.

Highlights:

- Carla completed her review of modern birds' beak bone morphology and its application to the study of the palaeoecology of fossil birds and submitted this for publication.
- She presented her work at the International Symposium for Palaeohistology held in Cape Town in July 2019, where it was well received by the palaeornithology community.

Impact of the project

This work will help us better understand the links between anatomy, morphology and behaviour in birds. From a conservation and global change perspective, it will allow a better understanding of the substrate conditions under which ibises are best equipped to forage, improving our understanding of potential mechanisms underlying the expansion of Hadedas into the south and west of South Africa, and the likely impact of the current drought and ongoing climate drying on the foraging success of this species. The comparative work on palaeontological specimens will improve our understanding of the ecology of extinct birds, and shed light on both the evolution of this unique sensory system in modern birds, and potentially alter our understanding of the morphology and behaviour of some of the earliest ancestors of large clades of modern birds.

Key co-supporters

DST-NRF CoE grant; DST-NRF CoE in Paleosciences.

Research team 2019

Dr Susan Cunningham (FIAO, UCT)
Prof. Anusuya Chinsamy-Turan (Biological Sciences, UCT)
Dr Steve Portugal (Royal Holloway, U. London)
Dr Anton du Plessis (U. Stellenbosch)

Student: Carla du Toit (PhD, UCT)

Impacts of power infrastructure

This project attempts to mitigate the impacts of power generation and transmission infrastructure on birds and other biota. Initial attention was focused on collision impacts associated with powerlines, which mainly affect large, open-country birds such as bustards and cranes that are unable to react rapidly when they encounter aerial obstructions. More recently the project has considered the impacts of renewable energy technologies, including wind and solar power generation.

Wind and solar power generation have much less broad-scale environmental impact than the coal-fired power stations on which South Africa relies for most of its power generation, but both technologies can have significant impacts at a local scale. The aim of this programme is to provide practical solutions to reduce the impacts of renewable energy projects, as well as energy transmission infrastructure, on birds in southern Africa. The programme is run in close collaboration with BirdLife South Africa's Birds and Renewable Energy programme and the Endangered Wildlife Trust. Modelling the impacts of wind farms on Verreaux's Eagles *Aquila verreauxii* is reported separately in the section 'Ecology and conservation of Verreaux's Eagles' (Page 29).

Christie Craig setting out a camera trap to monitor a goose carcass in the Karoo. Recording scavenger removal allows us to estimate the proportion of birds recovered by powerline surveys (Photo: Bradley Gibbons).

Activities in 2019

- Former CB MSc student Christie Craig, now based at the Endangered Wildlife Trust, began work on a project looking at the viability of Blue Cranes *Grus paradisea* in their core range in the Western Cape and Karoo. She will register for a PhD at the Fitz from Feb 2020. The project has a strong focus on the impact of powerlines on Blue Cranes. In 2019, 150 km of powerline transects were walked in the Swartland and 160 km in the Karoo to quantify avian collisions on powerlines. Preliminary results from the Swartland are similar to surveys done in the Overberg by Jessica Shaw (CB MSc 2008), with four times more mortalities on transmission lines than on distribution lines. Scavenger trials also were conducted, and found little if any loss of carcasses due to scavengers in the Swartland, but more than half of all carcasses in the Karoo disappeared within a few days, suggesting that only a small proportion of powerline casualties will be detected by checking lines every few months. Further trials are planned for 2020.
- Mark Rule from the Bateleurs flew two aerial surveys to count Blue Cranes during the November breeding season, one in the Swartland and one in the Overberg. These flights complemented winter aerial surveys conducted in 2018, and will help to ground-truth estimates of Blue Crane numbers in the Western Cape.
- Christie's project also focuses on potential socio-economic impacts on Blue Cranes given that the species mainly uses agricultural land in the Western Cape. Interviews were conducted with farmers to gather insights into local agricultural trends, the potential impacts of climate change on land use in the Overberg and Swartland regions, and how these may affect habitat suitability for Blue Cranes. Preliminary observations from the interviews indicate that farmer's plans to adapt to climate change were mixed and in some cases contradictory. For example, many farmers plan to diversify and focus more on livestock if crop yields decrease, while others plan to move towards a cropping only system, to maximise profits. In 2020, more interviews will be done to help get a clearer sense of what can be expected in this landscape.
- MSc student Robin Colyn continued fieldwork aimed at better understanding the factors determining the distributions of range-restricted larks in the Karoo regions of southern

A Red Lark carrying nesting material a few days before rain fell near Springbok (Photo: Robin Colyn).

Africa. The Red Lark *Certhilauda burra* is a species of particular concern, given the large number of wind energy projects planned in the range of this localised, vulnerable species, and the high mortality rate of larks that undertake aerial displays at windfarms. Using a range-finder that also measures the angle of elevation, Robin found that average flight height of displaying males is around 50 m, which definitely places them at risk of collisions (blade heights range from 25-60 m above the ground). Some Red Larks were recorded displaying at more than 150 m above the ground.

- Given the recent expansion of renewable energy development and the associated delineation of development zones (i.e. Renewable Energy Development Zones [REDZ]) throughout the Northern Cape, Robin conducted field studies to identify critical habitat for range-restricted lark species. Using a combination of field data (63 transects and 150 vegetation plots conducted in 2019), remote sensing and predicative modelling, the project aims to delineate core habitats for each species in South Africa: Red Lark, Barlow's Lark *C. barlowi*, Sclater's Lark *Spizocorys sclateri* and Stark's Lark *S. starki*. The first model identified micro-habitats in terms of substratum (calcrete, gravel, sand, rocky outcrop, etc.) and dominant vegetation structure (shrubs, annual forb, grasses, etc.). The next phase of modelling will involve distance sampling to determine lark densities in different habitats, followed by climate change modelling to determine areas of projected stability.
- Robin also completed similar fieldwork and modelling aimed at better understanding the factors determining the distributions of range-restricted larks and pipits in the highland grassland regions of South Africa. The establishment of a REDZ within this region in 2018 could further threaten Yellow-breasted Pipits *Hemimacronyx chloris*, Rudd's Larks *Heteromirafra ruddi* and Botha's Larks *Spizocorys fringillaris*. Ecological circuit theory is being used to establish connectivity pathways between identified core habitats and delineate the optimum conservation network for conserving these range-restricted and habitat specialist species.
- Vonica Perold, Peter Ryan and Sam Ralston-Paton (BLSA) reviewed bird mortality monitoring reports at wind energy facilities around South Africa. Although most casualties are raptors and swifts, 130 species of birds have been reported killed at 20 windfarms. Species accumulation models suggest that around 40% of species found in the vicinity of wind farms will be killed at least occasionally. A paper reporting these findings is under review.

Highlights:

- Two papers from Corey Jeal's CB MSc project on the impacts of a concentrated solar power 'trough' facility were published, one recording the relatively minor impacts on birds resulting from this type of facility, and one assessing how macro-invertebrate communities are impacted.
- A paper summarising the efficacy of transmission line marking (using flappers or static flight diverters) to reduce collision mortality in the eastern Nama Karoo, was drafted by Jess Shaw.

Key co-supporters

Endangered Wildlife Trust-Eskom Strategic Partnership, The Bateleurs, Hans Hoheisen Charitable Trust, Leiden Conservation Fund, Dave Myers.

Research team 2019

Prof. Peter Ryan (FIAO, UCT)
A/Prof. Arjun Amar (FIAO, UCT)
Christie Craig (EWT)
Dr Andrew Jenkins (ADU, UCT)
Dr Megan Murgatroyd (FIAO, UCT)
Vonica Perold (FIAO, UCT)
Samantha Ralston-Paton (BLSA)
Dr Tim Reid (ANU, Canberra)
Dr Jess Shaw (Scottish Natural Heritage)
Tanya Smith (EWT)

Student: Robin Colyn (MSc, UCT)

Ecology and conservation of Verreaux's Eagles

In 2015 the conservation status of Verreaux's Eagle *Aquila verreauxii* in southern Africa was changed from Least Concern to Vulnerable due to decreases in range and abundance recorded by the South African Bird Atlas Project. Our project on this species initially focused on investigating the potential impacts of land use change and habitat loss in the Western Cape. Generally regarded as a highly specialised raptor, habitat transformation was predicted to reduce availability of its preferred prey species, the Rock Hyrax *Procavia capensis*, resulting in reduced breeding productivity or increased foraging effort. Contrary to this prediction, we found that Verreaux's Eagles had more diverse diets in agriculturally developed areas and that breeding productivity was not affected by the levels of agricultural transformation currently experienced in the Sandveld region. A more recent and national threat is the development of wind turbine farms, and efforts have now shifted toward modelling the potential impacts of wind energy developments on this species.

The demand for renewable power is increasing worldwide and the installed electricity generation from wind power is growing rapidly. In South Africa, wind energy has grown at a rapid rate, with over 1 100 wind turbines becoming operational in the past five years and this trend can be expected to continue to rise rapidly. Wind energy is often regarded as a sustainable solution to our increasing energy demands. However, there are negative impacts on birds through collisions with rotor blades. In South Africa, post construction monitoring has found that diurnal raptors are the most frequently killed bird guild, representing around 35% of all casualties recorded. This disproportionate effect on raptors is extremely worrying and we are working towards predictive collision risk models for the most at risk species. Verreaux's Eagles are highly susceptible to collisions, with mortalities recorded at several wind energy facilities. We have built a predictive mapping tool to enable turbine placement to occur in areas that minimise the risk of collision for this species. This used high-resolution GPS tracking technology to understand flight behaviour, habitat use and the associated risk of wind turbine collisions. The resultant collision risk model is now being used by the wind energy industry to obtain collision risk maps of potential development areas early in the planning stage, thereby ensuring that wind turbines can be placed in locations that will minimise risk to eagles.

Verreaux's Eagles' soaring flight puts them at particular risk of colliding with wind turbines, but also means their flight behaviour can be modelled and predicted in relation to landscape features that drive uplift (Photo: Megan Murgatroyd).

Activities in 2019

- Fieldwork during 2019 included ongoing monitoring of the GPS tagged Verreaux's Eagles in the Karoo, Overberg and West Coast areas. Due to the large volume of data generated by the tags (over 1,000,000 fixes during 2019) data downloads are done via base stations (rather than via satellite), which requires frequent maintenance of remote field equipment.

- In 2019, we combined all the tracking data into a realistic collision model, which was then tested in its Beta form at a number of planned wind farm sites.
- We developed a collaboration with Merlyn Nkomo and BirdLife Zimbabwe, for Merlyn to analyse the long-running Verreaux Eagle data from the Matapos Hills first initiated by Valarie Gargett. This research will be undertaken by Merlyn for her Conservation Biology MSc thesis in 2020.

Highlights:

- The final version of the risk model, built using data from 16 tagged eagles, has been used at a number of wind farm sites, at the request of DEA, confirming the demand for such models.
- A paper describing the model has been submitted to the *Journal of Applied Ecology* and is currently in review.
- Dr Megan Murgatroyd was awarded the Leslie Brown memorial grant from the Raptor Research Foundation to track Verreaux's Eagles in East Africa, in order to test the generalizability of our model in a different region.
- Megan fledged from the Fitz and secured a position as HawkWatch International's (HWI) first truly international conservation biologist. HWI work to conserve raptors and our shared environment and we now look forward to growing collaborations and continuing to work closely with Megan on this project.

Verreaux's Eagles with their two-week old chick on a nest in the Cedarberg (Photo: Megan Murgatroyd).

A fledgling Verreaux's Eagle perched on a cliff is the 4th consecutive successful breeding attempt by one of our tagged eagles in the Karoo (Photo: Megan Murgatroyd).

Impact of the project

This project has added to our understanding of the ecology and habitat requirements of Verreaux's Eagles. The primary aim of the ongoing work is to contribute to reducing future injuries and mortalities of Verreaux's Eagles due to wind turbine collisions throughout their range. This will contribute to the long-term sustainability of wind energy development within Sub-Saharan Africa and minimise the impact on one of Africa's most widespread and vulnerable eagle species.

Key co-supporters

ABAX Foundation; DST-NRF CoE grant; BirdLife South Africa; Hawk Mountain Sanctuary; Mainstream Renewables; Avisense Consulting; Tygerberg Bird Club

Research team 2019

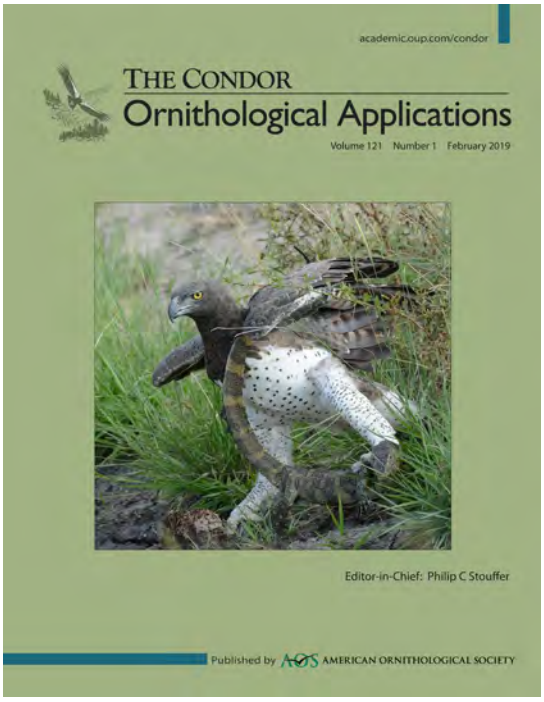
A/Prof. Arjun Amar (FIAO, UCT)
Dr Megan Murgatroyd (HawkWatch International / EWT / FIAO, UCT)

Conserving Martial Eagles

The project aims to understand the factors driving a decrease in the population of Martial Eagles *Polemaetus bellicosus* in South Africa, with a particular focus on the declines observed within the largest protected area in the country, the Kruger National Park (KNP). This research is important to understand the role that protected areas have in species conservation and to understand specific threats and habitat requirements for the conservation of Martial Eagles.

The project was initiated in response to the decline in reporting rates of Martial Eagles between the Southern African Bird Atlas Projects (SABAP) 1 (1987–1992) and 2 (2007–2012). These surveys suggest population declines of up to 65% across South Africa. Declines were also observed inside large protected areas, such as the KNP, which experienced a 54% decline in reporting rate over this time.

We aim to improve our understanding of the threats faced by this species and how these threats may drive population declines even within protected areas, where species are usually expected to be conserved. Our original hypothesis for these declines was that Martial Eagles may be subject to increased mortality outside of protected areas, particularly during immature life stages when inexperienced eagles are likely to range outside protected areas. Contrary to this hypothesis, we have not found evidence for low survival during these early life stages despite ranging widely beyond protected area boundaries. However, through GPS tracking of adult birds and nest monitoring, two potential factors that may be contributing to the observed population declines have been detected: low adult survival and poor breeding productivity. Adult mortalities, including persecution and electrocution, during unexpected wide-ranging movements outside of the KNP, may be contributing to declines. The poor breeding productivity comes in two forms: both a lower than average number of pairs making a breeding attempt and low breeding success. We are continuing study the breeding performance of this species in the KNP to enable a more comprehensive understanding of the environmental drivers of poor breeding performance, as well as continuing to track eagles to determine the frequency and cause of mortalities.



A photo that we used to describe the diet of Martial Eagles from web-sourced photos across their African range was chosen by *Condor* for the cover of the issue featuring our paper.

Activities in 2019

- In 2019 we monitored 23 breeding territories which were considered to be occupied. Of these, there were only nine breeding attempts, of which three failed and six were successful. This equates to a breeding productivity of 0.26 young per pair, which is similar to previous years.
- Five nest cameras were installed: one nest was successful; two were regularly visited by eagles but not active; one was not useable due to a bad camera angle and at one the tree fell down (however we know from the camera that the nest was not being used this year by eagles).
- We commenced a collaboration with researchers from the Mara Raptor Project who have been studying Martial Eagles in Kenya

In 2019, we again successfully deployed trail cameras at a number of Martial Eagle nests in Kruger National Park. These cameras will provide useful information on diet and causes of breeding failure, about which we still know very little (Nest camera photo).

since 2016. Using GPS transmitters, they have developed a method to rapidly identify kill locations and by visiting these sites they have uncovered detailed information on dietary requirements which differ between male and female eagles. A clear understanding of these requirements may help us to tease apart the drivers of poor success and to understand the conservation requirements of the species. The Mara Project has provided us with six of their GPS transmitters, of which two were deployed in 2019.

- Conservation Biology MSc student Rene Brink used data from this project as part of her thesis which examined whether circular buffers around nests adequately protect the ranging behaviours of raptors in Southern Africa.

Highlights

- The first consecutive successful breeding attempt by a pair of Martial Eagles was recorded this year. The female of this nest was equipped with a microwave telemetry transmitter (sponsored by Jock's Safari Lodge in 2018).
- A paper exploring the diet of Martial Eagles across their African range using photos sourced from the internet was published in the journal *Condor*. This collaborative paper involved several undergraduate and postgraduate students.
- Conservation Biology MSc student Daryl van der Merwe successfully completed his MSc thesis. Daryl analysed all of the breeding data collected to date to explore which environmental factors were associated with variation in breeding success.

Impact of the project

Our research indicates that protected areas alone are unlikely to conserve this species and that additional conservation measures, such as education programmes, or trans-boundary policy should be put in place to ensure the successful conservation of this species.

Key co-supporters

ABAX Foundation; DST-NRF CoE grant; Endangered Wildlife Trust; Jock's Safari Lodge.

Research team 2019

A/Prof. Arjun Amar (FIAO, UCT)
Dr Megan Murgatroyd (HawkWatch International / EWT / FIAO, UCT)
John Davies (Endangered Wildlife Trust)
Dr Gareth Tate (Endangered Wildlife Trust)
Dr Lindy Thompson (Endangered Wildlife Trust)

Students: Rene Brink (CB MSc, UCT); Daryl van der Merwe (CB MSc, UCT).

Vulture conservation

We are currently experiencing what some have described as an African Vulture Crisis. The rapid decrease in vulture numbers across Africa was recently highlighted when parties to the Convention of Migratory Species unanimously adopted the Multi-species Action Plan to Conserve African-Eurasian Vultures (Vulture MsAP). Several populations of vultures have declined by up to 95% over the last few decades. Unlike the Asian Vulture Crisis, where the collapse of vulture populations had a single main cause (the veterinary drug – diclofenac), there appear to be multiple drivers for the situation in Africa, with the importance of each varying between species and regions.

Vultures provide important ecosystem services and their declines or disappearances will have a dramatic effect on people and wildlife in Africa. The FitzPatrick Institute is committed to help conserve vultures in Africa by engaging in a number of research projects on multiple species in several countries in southern Africa.

Working with Raptors Botswana, we are involved in a research programme on Botswana's significant populations of vultures. All five species in the country are endangered or critically endangered. Central to this research is an attempt to quantify changes in vulture populations in Botswana over the last 20 years by repeating road transects undertaken in the early 1990s, as well as to undertake repeat aerial surveys of some important colonies. We have completed these resurveys across northern Botswana and are now attempting to resurvey these historical transects in the south of the country.

We remain a key partner in the conservation of the Bearded Vulture *Gypaetus barbatus* in southern Africa. Sonja Krüger from Ezemvelo KZN Wildlife completed her PhD research on the conservation of this population at the Fitz in 2014 and we continue to collaborate with her and others on the conservation of this important population. More recently, the conservation focus has shifted to building a captive breeding programme with the hope of establishing an 'insurance' population away from the Maloti-Drakensberg Mountain population. This project builds on the research Christiaan Brink conducted for his Conservation Biology MSc in 2015.

We reinvigorated a project, first initiated by Ezemvelo KZN Wildlife, to build a wind farm collision risk model for Cape Vultures *Gyps coprotheres* across their entire range. In 2019, we

Vulture supplementary feeding site or 'restaurant'. The farmer had just offloaded the meat he wished to discard. The vulture clean-up crew arrived soon thereafter (Photo: Robert Trollip).

collated data from most organisations that have tracked Cape Vultures in southern Africa. Using these data, and building on our experiences with similar models for Bearded Vultures and Verreaux's Eagles *Aquila verreauxi,* we are producing a risk model that will help to ensure that developers can avoid siting wind turbines in the more sensitive locations for this species and thereby minimise collision risks with this threatened species.

With collaborators VulPro, EWT, CSVet and Ezemvelo KZN Wildlife, we have collated, updated and verified a national database of vulture supplementary feeding stations (SFS) in South Africa. These spatial data on feeding sites and their provisioning rates provide a valuable tool in conservation planning and will facilitate future research in determining the effect of SFS on aspects of vulture biology such as demography and their movement ecology.

In an effort to understand the prevalence and spatial distribution of poison-use for predator

An African White-backed Vulture scrounges for scraps at a carcass (Photo: Gareth Tate).

control, we have conducted interviews with farmers across the country. With these data we aim to produce a heatmap of poison-use for South Africa and identify the drivers that predict a landowner's propensity to engage in poison use. The results from this study will have important implications for the conservation management of vultures.

Activities in 2019

- Christiaan Brink produced an updated national database of vulture supplementary feeding stations for South Africa. This database is a collaborative project with multiple organisations working together for vulture conservation.
- Christiaan, Arjun Amar and Sonja Kruger submitted a paper to *Ostrich* assessing the best site and release strategy for a Bearded Vulture reintroduction in South Africa.
- Christiaan interviewed 823 farmers across South Africa about the prevalence of poison-use for predator control and general attitudes towards vultures.
- Led by Vultures Namibia, eight juvenile Lappet-faced Vultures *Torgos tracheliotos* have been fitted with GPS tracking units within the Namib Naukluft National Park to study early-life movements and survival in this harsh landscape.
- Rochelle Mphetlhe, working in collaboration with Raptors Botswana, commenced a repeat of nearly 25,000 km of raptor road transects, first surveyed in the 1990s in southern Botswana. Rochelle plans to register for a MSc in 2020.

Highlights

- Together with other colleagues, Christiaan, Arjun, Robert Thomson, and Andrea Santangeli published a paper from Christiaan's PhD study in *Animal Conservation* about the spatial distribution and resource contribution of vulture supplementary feeding sites in South Africa.
- Leungo Leepile's Conservation Biology MSc project documenting the changes in nesting numbers and breeding success of African White-backed Vultures *Gyps africanus* in northern Botswana was accepted for publication in *Bird Conservation International*.

Impact of the project

Our research aims to understand important ecological issues affecting vultures, quantify population trends of multiple species, and identify key drivers of their population declines. Using our research on vulture restaurants, poison use, blood lead levels and hunting, and more recently with our research on reintroductions, we hope to deliver solutions to help reverse the declines in these species in Africa. The outcomes of these projects will help us understand why, what, where and how vulture threats occur, with implications for targeting cost-effective conservation actions.

Key co-supporters

DST-NRF CoE grant; NRF Innovation Scholarship; JW Jagger Grant; Denver Zoo; Raptors Botswana; Rufford Grant; Wilderness Wildlife Trust; Colombus Zoo; Mohammed bin Zayed Species Conservation Fund; Leslie Brown Memorial Grant; Peregrine Fund; IDEA Wild; British Ecological Society; Ezemvelo KZN Wildlife; Endangered Wildlife Trust; N3TC through Wildlands, Vultures Namibia, VulPro, HawkWatch International, University of Marburg.

Research team 2019

A/Prof. Arjun Amar (FIAO, UCT)
Dr Robert Thomson (FIAO, UCT)
Dr Sonja Krüger (EKZN Wildlife)
Dr Andrea Santangeli (U. Helsinki, Finland)
Ms Kerri Wolter (VulPro)
Dr Glyn Maude (Raptors Botswana)
Dr Richard Reading (Raptors Botswana)
Dr Gareth Tate (Endangered Wildlife Trust)
Dr Andrew Tucker (CSVet, Pretoria)
Dr Megan Murgatroyd (HawkWatch International)
Dr Beckie Garbett (Birdlife International)
Dr Chris Briggs (Hamilton College, USA)

Student: Christiaan Brink (PhD, UCT)

Southern Ground-Hornbill conservation

Southern Ground-Hornbills *Bucorvus leadbeateri* are large, group-living birds which require extensive territories and relatively undisturbed areas with large trees for breeding and roosting. With high rates of habitat destruction during the past century, which has accelerated in recent decades, these requirements have become increasingly rare, leading to a two-thirds reduction in the Southern Ground-Hornbill's range within South Africa. A long-term study at the Fitz, initiated in 2000, has been investigating their habitat use, reproductive success, and natal and breeding dispersal. Now we are building on this foundation to study the social behaviour in more detail, specifically how group members contribute to vital group functions such as territory defence and reproduction, and whether larger groups are more resilient when facing extreme climate events.

The current focus of the project, located in the Associated Private Nature Reserves (APNR) adjacent to the central Kruger National Park, is on better understanding the species' social structure and individual contributions to breeding success and territory defence. The study provided nest boxes to 20 groups which collectively make 12-15 breeding attempts each year. PhD student Kyle-Mark Middleton, supervised by Dr Rita Covas, Prof. Claire Spottiswoode and Dr Fanny Rybak, has obtained many hours of recordings of the different groups' dawn chorus and in 2019 travelled to Paris to analyse the vocalisations with Fanny Rybak. These analyses have shown differences between the sexes, and among the vocalisations of different individuals. Play-back experiments were planned to assess if the birds also perceive these vocalisations as different. However, due to late rains and high temperatures in the 2018/19 breeding season, very few groups attempted to breed and the play-back experiment was postponed until the 2019/20 breeding season.

Kyle has also obtained footage from camera traps installed at the nests which has allowed for the private lives of ground-hornbills to be investigated and analysed. Initial results reveal interesting disproportionate contributions from individuals in the groups.

This project is closely linked to the Mabula Ground-Hornbill Project. We provide the second-hatched chicks from our population, which invariably die of starvation in the wild, to be captive-reared and later released as founder groups in new areas.

Activities in 2019

- Kyle Middleton upgraded from a MSc to PhD. He is researching the cooperative breeding behaviour and vocalisations of Southern Ground-Hornbills within the APNR.
- Kyle joined Fanny Rybak at U. Paris-Sud, to continue the analyses of group and individual vocalisations. The results suggest that different territorial groups have unique 'signatures', and that male birds produce vocalisations at a lower frequency than that of females.
- The repertoire of ground-hornbills consists of six different vocalisations used for different situations: chorus, contact, excitement, alarm, begging and feeding calls. A distress call is also suspected to occur, but this could not be recorded.
- The first playback experiments were conducted to investigate whether groups are able to recognise neighbouring groups from stranger groups through vocalisations.
- Kyle travelled to Portugal to join Rita Covas at CIBIO (U. Porto) to begin the analysis of long-term breeding success in relation to environmental variables and group structure.
- Before the breeding season began, camera traps were placed in camouflaged boxes at 12 nests, to record birds provisioning food at the nest.
- Initial camera trap analysis shows that adult males contribute more to the feeding of the incubating female and chick than sub-adult male helpers. It also appears that juvenile birds are unaware of the provisioning process.
- Continued efforts to identify individuals by non-invasive techniques using camera traps to

photograph the birds' face yielded positive results, suggesting that distinctive facial features are an effective method of identification. This is being used to study the individual contributions to nestling feeding.

- Genetic sample collection for known individuals is continuing through non-invasive methods from shed feathers. This is to determine relatedness between individuals and how this influences investment in cooperative behaviour.
- Three of Kate Carstens' PhD chapters where published as peer-reviewed papers in *Bird Conservation International, Journal of Ornithology* and *Ostrich*.
- Rob Little represents the Fitz on the national Southern Ground-Hornbill Working Group and is Vice Chairman of the Mabula Ground-Hornbill Project management board.
- During 2019, the project gave ten presentations to the general public (including one local school) to create awareness and published four articles in the magazine *Klaserie Chronicle* which is distributed to surrounding private reserves and the greater Hoedspruit community.
- An article was published in *Kruger Magazine* presenting the project's history and aims. Some reserves surrounding the APNR are showing increased attention towards the species and their conservation.

Highlights:

- A generous donation from the Mary Oppenheimer and Daughters Foundation, supplemented by some of the homeowners in the APNR, allowed the project to purchase a new vehicle. This will allow the project to continue for the foreseeable future.
- Kyle received funding for his research from the National Geographic Society.
- The Mabula Ground-Hornbill Project held an avian first aid course which Kyle attended to aid field conservation.
- A group of ground-hornbills was confirmed to have two females in the group, both of which were contributing towards the feeding of the offspring, something never seen before.
- An injured ground-hornbill was found inside a nest. This bird was taken to Onderstepoort Veterinary Hospital where it was rehabilitated and then released back into the APNR.

Kyle Middleton and Carrie Hickman celebrate the arrival of the new project vehicle.

- The 2018/19 breeding season saw only five active nests, and all five chicks successfully fledged.
- Egg candling was used to provide an accurate estimate of the hatch date for harvesting and methods are being developed to sex birds whilst still in the egg.
- Ongoing repairs to and replacement of artificial nest boxes ensure that ground-hornbills can continue to thrive in an area which has a paucity of natural nest cavities. The new nest designs were installed and one of them was used immediately.

Impact of the project

This project has contributed significantly to the population growth of Southern Ground-Hornbills in the APNR as a result of the installation of artificial nests and has demonstrated the efficacy of these nest boxes as a conservation tool, particularly in areas that have a shortage of large trees with natural cavities. These results contributed to the national Southern Ground-Hornbill Species Action Plan and to the Southern Ground-Hornbill Reintroduction Plan and assist with their implementation.

Key co-supporters

DST-NRF CoE grant; The Foundation for Science and Technology FCT, Portugal; Associated Private Nature Reserves; National Geographic Society; Mary Oppenheimer & Daughters Foundation.

Research team 2019

Dr Rita Covas (FIAO, UCT and CIBIO, U. Porto)
Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
Dr Fanny Rybak (U. Paris-Sud, France)
Dr Rob Little (FIAO, UCT)

Student: Kyle-Mark Middleton (PhD, UCT)

Research Assistant: Carrie Hickman.

Conserving Benguela endemic seabirds

All three seabirds endemic to the Benguela upwelling ecosystem that rely on anchovies and sardines are threatened by local reductions in the availability of their preferred prey. Small pelagic fish abundance has decreased off the southern African west coast, where fishing effort is concentrated, and most seabird breeding islands are located. As a result, it is crucial to understand the foraging behaviour of breeding seabirds and how their populations respond to changes in fish abundance and distribution.

The lack of spatial management of the fishery for small pelagic fish has resulted in local over-exploitation of sardines and anchovy. In 2019, the sardine fishing industry virtually collapsed, with no catches made on the west coast and <1000 tons caught in Algoa Bay. Conditions for African Penguins *Spheniscus demersus*, Cape Cormorants *Phalacrocorax capensis* and Cape Gannets *Morus capensis* breeding at west coast locations were at their poorest recorded since the beginning of the long-term study initiated at the Fitz in 2002 for gannets and 2007 for penguins. Worryingly, numbers of penguins breeding in Algoa Bay, which has supported more than half the world population in recent years, also fell sharply, mainly due to a population collapse on St Croix Island. Understanding the drivers behind such population changes is essential to mitigate these declines. This is a large, multi-faceted programme with key participants including Pierre Pistorius, Lorien Pichegru and Maëlle Connan (NMU), David Grémillet (CNRS Montpellier), former post-docs Tim Cook (Paris) and Richard Sherley (Bristol), collaborators at BLSA (Alistair McInnes, Christina Hagen) and DEA (Azwianewi Makhado and Rob Crawford), as well as several post-doctoral students.

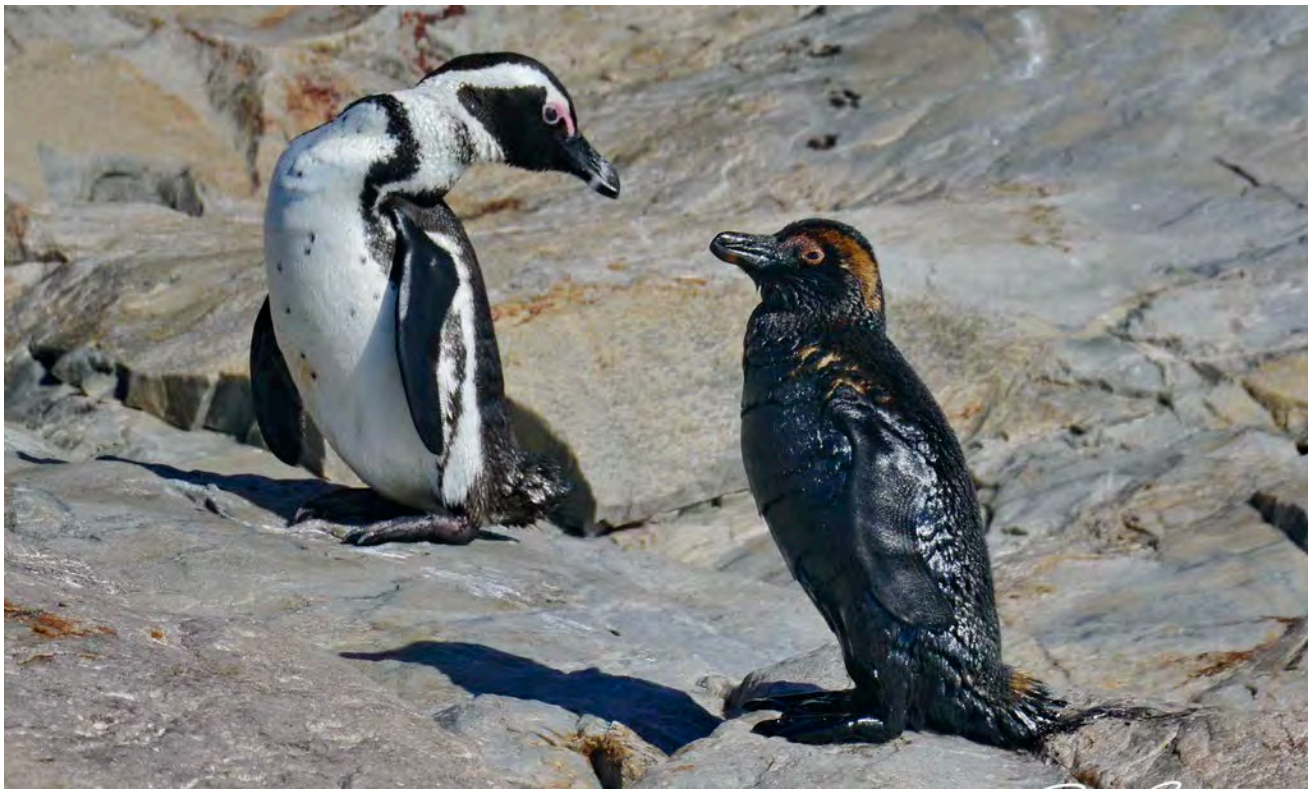
MSc student Ilana Engelbrecht capturing a Cape Gannet on Bird Island, Algoa Bay for the deployment of a GPS tracking device (Photo: Pierre Pistorius).

Activities in 2019

- Alistair McInnes completed his post-doc at NMU on the use of seabirds as real-time monitors of pelagic fish availability. Working mainly at Stony Point, Betty's Bay, home to the only increasing population of African Penguins, he used penguin cameras, GPS loggers and weigh-bridges to measure how hard penguins have to work to catch prey. In a paper published in *Ibis*, he demonstrated penguin calling behaviour depends on the number of penguins in the vicinity as well as on the prey that they target. Solitary birds call more often than birds in groups, highlighting the importance of gathering in groups to increase foraging efficiency when targeting schooling prey. In another paper he showed how prey herding by African Penguins benefits a number of other seabird species such as Sooty Shearwaters *Ardenna grisea* and Cape Cormorants. This process of facilitation demonstrates the import role penguins plays in the functioning of local marine ecosystems.
- Former NMU post-doc and vet, Ralph Vanstreels, continued to publish papers from his research while at NMU. He summarised post-mortem examinations of penguins found dead at mainland breeding colonies to describe the injuries characteristic of penguins attacked by leopards, caracals, domestic dogs and Cape grey mongooses.
- NMU MSc student Catherine Currin is exploring the use of a remote heart-rate recorder for

African Penguins designed by an Honours student at NMU's Department of Mechatronics, to contrast stress levels in wild and captive penguin colonies.

- NMU post-doc, Giannina Passuni, mentored by Lorien Pichegru and NMU's Nadine Strydom, has been investigating the contribution of African Penguin guano from St Croix Island on water quality and productivity around the colony. She estimated that 45.4 tons of N and 8.4 tons of P were produced annually by the birds although only 5-20% of the N washed into the ocean. As a result, water quality and productivity were similar close to (200 m) and farther offshore (2 km) from the colony, suggesting limited influence of penguin excreta on the immediate marine environment.
- The experimental closure of commercial fishing for small pelagic fish around key penguin breeding islands continued in 2019, despite strong evidence that fishing close to breeding colonies has a strong adverse effect on African Penguins. Virtually the entire catch of sardine in 2019 was caught close to St Croix Island, the world's largest African Penguin colony, where fishing was re-opened in 2018. Penguin breeding numbers at St Croix in 2019 halved from 2018 and were a third of 2015, resulting in calls being made to ban purse-seine fishing around African Penguin colonies. Sadly, no decision was made to institute permanent closures, and the waters around St Croix colony remain open to fishing. Penguins are under further pressure at this colony due to controversial ship-to-ship bunkering operations near the island, which has resulted in several spills that have oiled penguins and other seabirds.
- NMU MSc student Praxedes Rukuni, co-supervised by Lorien, Giannina and Dr Shaun Deyzel from SAEON, is investigating food web stability in Algoa Bay using meso-zooplankton functional diversity metrics. Praxedes compared the stomach contents of anchovies eaten by African Penguins to the diversity and biomass of zooplankton collected across the bay. Her aim is to calculate the functional diversity of the zooplankton community to infer the stability of the pelagic food web.
- Lorien also supervised NMU MSc student Tayla Ginsburg, who investigated how a Dynamic Ocean Management (DOM) plan could allow



A heavily oiled African Penguin on St Croix Island in Algoa Bay. An article in *The Conversation* from researchers at the Fitz, BirdLife SA and SANCCOB highlighted the threat posed by ship-to-ship refuelling in Algoa Bay, which is in contravention of the Marine Pollution Act 6 of 1981 (Photo: Lloyd Edwards).

Katharina Reusch waits to trigger a noose trap to recover a GPS logger deployed on a Kelp Gull incubating at the Swartkops Estuary (Photo: Titus Shaanika).

fishing to occur around colonies when fish abundance is high, thereby reducing the cost of local closures to the fishery. Although she found that such a plan could work, the current extremely low levels of fish stocks prevent such an approach.

- NMU PhD student Katharina Reusch continued her study of the foraging ecology of Kelp Gulls *Larus dominicanus* using a variety of approaches including tracking breeding adults, stable isotope analyses and conventional diet studies. She has found marked differences among colonies in terms of foraging areas and diet, but in general adult Kelp Gulls seem to rely less on strongly modified habitats, such as landfills, than expected. In collaboration with Dr Nola Parsons, she also has compared blood and intestinal parasite loads among colonies.
- Ilana Engelbrecht continued working on her MSc with Pierre Pistorius on foraging strategies and within-pair synchronization in Cape Gannets at Bird Island. The project is based on the extensive set of foraging trip durations of individuals tagged with VHF transponders.
- David Grémillet and Lorien Pichegru continued their long-term study tracking the foraging ranges of Cape Gannets breeding on Malgas Island, which was initiated in 2002. With a team of students and volunteers, they monitored approximately 40 individuals of known-age to explore how experience influences foraging success. Gannet predation by Cape Fur Seals decreased thanks to active management by South African National Parks, however Kelp Gull predation on gannet eggs and chicks remained very high, leading to the start of active control measures against gulls in November 2019. Lorien was invited to a workshop organised by SANParks in April 2019 to advise on managing gull predation on seabird colonies.
- Pierre Pistorius continued monitoring Cape Gannets at Bird Island in Algoa Bay, and collected further tracking and demographic data from this colony. Post-doc Andrea Thiebault deployed acoustic recorders integrated with video-cameras on the gannets to better understand their vocal repertoire. Her paper in the *Journal of Avian Biology* showed how their calls at sea were context specific and probably improve foraging success.
- PhD student Emmanuel Adekola assisted with field work on Malgas Island while continuing his PhD on moult in Cape Gannets. He used the opportunity of working on known-age adults to test for age-specific differences in head coloration.
- A study led by Richard Sherley on the global threat status of Cape Gannets using a Bayesian approach concluded that the 45% decline in the last 50 years is slightly less than previously thought, and so the species may better fit the 'Vulnerable' rather than current 'Endangered' red list status. Nonetheless, the threats to the species are significant and include scarcity of

natural prey, especially off the west-coast, predation by gulls and fur seals, and extreme weather events.

Highlights:

- MSc student Laurie Johnson was awarded her degree.
- Dr Alistair McInnes was appointed Seabird Conservation Programme Manager for BirdLife South Africa.
- Fourteen papers were published in peer-reviewed journals during 2019.
- Lorien Pichegru participated in a collaborative study exploring the use of reference points for predators in ecosystem-based management to fisheries, using the example of penguins and sardines in South Africa, which was published in *Fish and Fisheries*.
- Lorien and MSc student Tayla Ginsberg co-authored a paper in *Frontiers in Marine Science* on the key challenges to advancing an ecosystem-based approach to marine spatial planning in South Africa.
- Pierre Pistorius and two post-grads gave talks at the 10th International Penguin Conference in New Zealand. Pierre was invited to give a presentation advising early career scientists how to pursue a scientific career.

Key co-supporters

BirdLife International; BirdLife South Africa; DST-NRF CoE grant.

Research team 2019

Prof. Pierre Pistorius (NMU)
Prof. Res Altwegg (SEEC, UCT)
Prof. Peter Ryan (FIAO, UCT
Dr Lorien Pichegru (NMU)
Dr Maëlle Connan (NMU)
Dr Timotheé Cook (U. Paris)
Dr Rob Crawford (Oceans & Coasts, DEA)
Dr Jon Green (U. Liverpool)
Dr David Grémillet (FIAO, UCT and CNRS)
Dr Azwianewi Makhado (Oceans & Coasts, DEA)
Dr Alistair McInnes (NMU Post-doc and BLSA)
Dr Florian Orgeret (NMU Post-doc)
Dr Giannina Passuni (NMU Post-doc)
Dr Richard Sherley (U. Bristol)
Dr Andrea Theibault (NMU Post-doc)
Dr Ralph Vanstreels (NMU Post-doc)
Dr Ross Wanless (FIAO, UCT and BLSA)

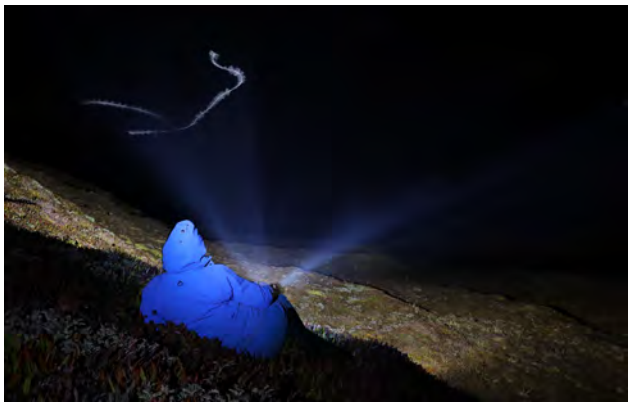
Students: Emmanuel Adekola (PhD, UCT); Katharina Reusch (PhD, NMU); Gwendoline Traisnel (PhD, NMU); Catherine Currin (MSc, NMU); Ilana Engelbrecht (MSc, NMU); Tayla Ginsburg (MSc, NMU); Laurie Johnson (MSc, UCT); Praxedes Rukuni (MSc, NMU).

A line of Cape Gannets slipstream each other over a glassy sea in Algoa Bay (Photo: Lloyd Edwards).

Conserving Southern Ocean seabirds

Seabirds are among the most threatened groups of birds because they face challenges both at their breeding sites and at sea. Almost one-third of all seabirds are on the global Red List, and they comprise nearly half of all threatened birds in South Africa. The Fitz's Seabird Research Programme assesses the severity of threats faced by seabirds, and attempts to provide practical management solutions to reduce these threats. Southern Ocean species are mainly threatened at sea by fishing mortality and climate change. Monitoring seabirds provides a window into the health of the Southern Ocean.

Most field work takes place through the South African National Antarctic Programme (SANAP) at the Prince Edward Islands, Tristan da Cunha and Gough Islands. Fitztitute seabird research on Marion Island, the larger of the two Prince Edward Islands, has continued unbroken since the early 1980s, when a series of long-term seabird study colonies were established by John Cooper. Servicing these long-term studies through a succession of three-year research projects is challenging, and currently is by three collaborative projects with CoE team members at NMU (Pierre Pistorius and Maëlle Connan) and DEA (Azwianewi Makhado) as well as Environmental Conservation Officers appointed by DEA. This project overlaps with the Island Conservation project (Page 43).



Janine Schoombie spotlights a prion on Marion Island. During 2019/20 Stefan Schoombie found Grey-backed Storm Petrels *Garrodia nereis* breeding on Marion Island for the first time (Photo: Stefan Schoombie).

Activities in 2019

- Peter Ryan and post-doc Ben Dilley published papers on population sizes and trends among seabirds breeding at Inaccessible and Nightingale Islands. Numbers of Spectacled Petrels *Procellaria conspicillata*, endemic to Inaccessible Island, continued to increase over the last decade, and a new census technique was implemented to provide a more sensitive way to track future population changes.
- Ben published the final paper from his PhD which assessed how different approaches to estimating burrowing petrel populations depend in part on the dispersion of nests. He also led on a paper reporting inter-species interactions among petrels in their nest burrows.
- NMU post-doc Andrea Thibault, working with Pierre Pistorius's group, reported the first evidence of penguins calling underwater while foraging, based on video footage from three sub-Antarctic penguin species.
- Florian Orgeret continued his post-doc at NMU, comparing seabird tracking data from Marion Island with similar data collected by French researchers at the neighbouring Crozet islands.
- Stefan Schoombie continued his PhD on fine-scale foraging behaviour of albatrosses and petrels. He published a paper describing an automated method to estimate bank angles in flying seabirds from video footage from bird-borne cameras. He is relating the insights into dynamic soaring learned from linking this footage to matched accelerometer and magnetometer data so that he can infer how albatrosses change their flight behaviour in relation to local wind conditions throughout their foraging trips. Stefan returned to Marion Island for a third year in April 2019 as field assistant on Maëlle Connan's SANAP project on burrowing petrels.
- NMU PhD student Tegan Carpenter-Kling published two papers: one on Gentoo Penguins as sentinels of climate change at the Prince Edward islands, and one on the factors affecting δ13C values of seabird tissues.

- Kim Stevens continued with her PhD on the demography and at-sea movements of Grey-headed Albatrosses *Thalassarche chrysostoma*. During the year she also collected seabird at-sea data on the spring SCALE cruise and mid-summer SANAE cruise.
- Alexis Osborne completed his MSc on the moult of Wandering Albatrosses and giant petrels while based on Gough Island, submitting the dissertation in early 2020.
- Lilli Ruiters continued an MSc at NMU identifying how reliant King Penguins from Marion Island are on productive foraging waters associated with the Antarctic Polar Front.
- Makabongwe Sigqala returned to over-winter on Marion Island while continuing part-time with his MSc on the diet of penguins.
- Maëlle Connan led on a paper on resource partitioning among sub-Antarctic seabirds based on analysis of stable isotopes in egg shells and egg membranes.
- Former PhD student Genevieve Jones published a paper on hybridisation between mollymawk albatrosses on Marion Island.
- The team contributed to six papers on seabird population structure and evolution: four papers on penguins, one on White-chinned Petrels *Procellaria aequinoctialis* and one on prion evolution.
- We also contributed to two global conservation reviews, one on petrels and the other on penguins.

Michelle Risi prepares to photograph the bill of a Sooty Albatross on Gough Island. She noticed that birds from the Atlantic colonies have richer yellow bill stripes than those from Indian Ocean colonies (Photo: Chris Jones).

- Several papers on seabird health also were published, including the first survey of perfluoroalkyl substances (PFASs) in Southern Ocean seabirds.
- Pierre Pistorius spent four months sabbatical working on tracking data from Marion Island at Otago University in Dunedin, New Zealand, hosted by Phil Seddon, a former Fitz post-doc.

Highlights:

- Ditiro Moloto was awarded her MSc for her study of structural adaptations for underwater flight among the albatrosses and petrels (Procellariiformes).
- Pierre Pistorius and Tegan Carpenter-Kling attended the 10th international Penguin conference in New Zealand where they presented the results from Marion Island penguin research.
- 25 papers on Southern Ocean seabirds and their conservation were published in 2019.

Key co-supporters

Agreement on the Conservation of Albatrosses and Petrels (ACAP); ACE Foundation; CNRS; DST-NRF CoE grant; European Union; RSPB; South African National Antarctic Programme; WWF Australia.

Research team 2019

Prof. Peter Ryan (FIAO, UCT)
Prof. Pierre Pistorius (NMU)
Prof. Res Altwegg (SEEC, UCT)
Dr Maelle Connan (NMU)
Dr Theresa Burg (U. Lethbridge, Canada)
Dr Sarah Convese (Oregon)
Dr Richard Cuthbert (formerly at RSPB)
Dr Jacob González-Solis (U. Barcelona)
Dr Akiko Kato (CNRS, Chize)
Dr Azwianewi Makhado (Oceans & Coasts, DEA)
Dr Richard Phillips (British Antarctic Survey)
Dr Rob Ronconi (Canadian Wildlife Service)
Dr Yan Ropert-Coudert (CNRS, Chize)
Dr Antje Steinfurth (FIAO, UCT)
Dr Ross Wanless (FIAO, UCT and BLSA)
Dr Henri Wiemerskirch (CNRS, Chize)
Prof. Rory Wilson (Swansea U.)

Students: Tegan Carpenter-Kling (PhD, NMU); Stefan Schoombie (PhD, UCT); Kim Stevens (PhD, UCT); Ditiro Moloto (MSc, UCT); Alexis Osborne (MSc, UCT); Makabongwe Sigqala (MSc, NMU); Lilli Ruiters (MSc, NMU).

Research assistants: Stefan Schoombie, Makabongwe Sigqala (Marion 2019/20).

Conserving islands and their birds

Oceanic islands hold a disproportionately large amount of terrestrial biodiversity, yet are extremely vulnerable to introduced species: more than 90% of recent bird extinctions have been of island birds. Fortunately, eradicating invasive species can restore island ecosystems, provided there are strict controls on the subsequent import of people and materials. Birds are flagships for the conservation-management and restoration of island ecosystems. Our work focusses on South Africa's Prince Edward Islands and the UK Overseas Territory of Tristan da Cunha and Gough Island.

This programme is mainly concerned with the impacts of introduced predators, especially House Mice *Mus musculus*, but also is involved in the eradication or control of introduced plants and invertebrates. The impacts of House Mice on seabirds were only discovered in the early 2000s, following research by Fitz students in collaboration with the Royal Society for the Protection of Birds (RSPB) at Gough Island. Since then, mice have been found to attack seabirds on Marion Island, and plans are underway to try to eradicate the species at both islands. Following a busy year for this project in 2018, when field work was conducted at Marion, Inaccessible and Nightingale Islands, 2019 was a year of consolidation, writing up papers, pushing forward on the policy front, and preparing for the next stage of field interventions.

Activities in 2019

- Two papers were published on Tristan Thrushes *Turdus eremita*, one revising population estimates for the species at Inaccessible and Nightingale Islands, and one on their consumption of intertidal invertebrates. The former paper used two different techniques (nest mapping and resightings of individually colour-marked birds) to conclude that the populations at the uninhabited Tristan islands are substantially larger than previously thought.
- A paper on the distribution and relative abundance of the Inaccessible Island Rail *Atlantisia rogersi* was submitted, showing that the species remains common throughout Inaccessible Island, and its population size is at least as large as that estimated in the early 1980s.
- A paper on the ongoing spread and rapid increase in impact of the introduced Soft Brown Scale *Coccus hesperidium* and its associated Sooty Mould *Seiridium phylicae* on *Phylica arborea* trees at both Inaccessible and Nightingale Islands was drafted. Because the fruit of these trees are crucial for the large-billed finches on these islands, the findings prompted the RSPB to investigate the viability of a biocontrol programme to limit the populations of Soft Brown Scale using parasitic wasps.
- Three years of mark-recapture data for Wilkins' *Nesospiza wilkinsi* and Nightingale Finches *N. questi* collected by Ben Dilley and Delia Davies on Nightingale Island from 2016 to 2018 were analysed in collaboration with Res Altwegg (SEEC) to estimate first year and adult survival. These data were then used in a PVA exercise by the Conservation Biology MSc class to assess the possible impacts of reduced *Phylica* fruit load on the tiny population of Wilkins' Finches confined to Nightingale Island.
- The programme to attempt to eradicate introduced House Mice from Gough Island, originally planned for winter 2019, was postponed until 2020. The plans for a follow-up eradication attempt to eradicate mice from Marion Island are also delayed until at least 2021. Peter Ryan remains involved in the planning for both attempts.
- Post-doc Susan Miller analysed genetic microsatellite data from Greg McClelland's PhD to explore population structure among Lesser Sheathbills *Chionis minor* at the Prince Edward Islands. She found that Prince Edward Island sheathbills nested within the diversity of sheathbills from Marion Island, being similar to birds from the north coast of Marion. This result suggests that genetic differentiation among the two island populations is trivial, and thus Prince Edward can be used as a rescue population for

A juvenile Gough Bunting *Rowettia goughensis* forages near an incubating female Tristan Albatross *Diomedea dabbenena* (Photo: Michelle Risi).

Marion Island should a large proportion of the sheathbills on Marion be killed during the mouse eradication attempt.

- Autumn surveys were conducted for the fifth successive year to monitor the spread of mouse attacks on large chicks of Grey-headed *Thalassarche chrysostoma* and sooty albatrosses *Phoebetria* spp. at Marion Island.
- A paper on confirming the impacts of Black Rats *Rattus rattus* on a colony of Broad-billed Prions *Pachyptila vittata* breeding in a coastal cave at Tristan da Cunha was drafted. Rat predation of seabirds' eggs and chicks is thought to be largely responsible for the low densities of burrow-nesting petrels at Tristan compared to other islands in the archipelago.
- Peter Ryan had the chance to visit the Pitcairn Islands in the central South Pacific in Oct-Nov 2019. Although his work focused on marine plastic pollution, he was able to gain useful insights into the biodiversity challenges faced by this UK Overseas Territory that shares many similarities to the Tristan archipelago.

Highlights:

- Ben Dilley was awarded his PhD on the impacts of mice on seabirds at Marion and Gough Islands. He remained at the Fitz writing up papers from his subsequent research at the Tristan archipelago.
- Andy Schofield (RSPB) put in a funding application to the Darwin Fund to support a three-year project to instigate biocontrol measures against Soft Brown Scale at the Tristan archipelago. Irrespective of the outcome of this funding, Dr Chris Malumphy, an entomologist specialising in the control of plant pests from Fera Science Limited, UK, will visit Tristan in early 2020 to assess the feasibility of using wasps to control Soft Brown Scale at the islands.
- Peter Ryan contributed to a global review paper in *PLoS ONE* identifying priority islands for restoration through eradication of introduced predators, led by Nic Holmes from Island Conservation.
- Chris Jones submitted a paper summarizing population trends in the Critically Endangered Gough Bunting *Rowettia goughensis* based on transect counts and territory mapping during the breeding season. The results suggest that the species is holding its own in the highlands of Gough, as the population has remained stable for the last decade or so.

Key co-supporters

Agreement on the Conservation of Albatrosses and Petrels; BirdLife International; DST-NRF CoE grant; EU-BEST; Royal Society for the Protection of Birds; South African National Antarctic Programme; UK Overseas Territories Environment Programme.

Research team 2019

Prof. Peter Ryan (FIAO, UCT)
Dr Alex Bond (formerly at the RSPB)
Dr Richard Cuthbert (formerly at the RSPB)
Dr Ben Dilley (FIAO, UCT)
Trevor Glass (Tristan Conservation Department)
Dr Stefan Oppel (RSPB)
Dr Susan Miller (FIAO, UCT)
Andy Schofield (RSPB)
Dr Ross Wanless (FIAO, UCT and BLSA)

Research assistants: Chris Jones, Michelle Risi and Alexis Osborne (Gough 2018/19 and 2019/20).

Hot Birds – Climate change and desert birds

2019 was the 10th anniversary of the 'Hot Birds Research Project' (HBRP), a programme that integrates behavioural and physiological approaches to predict the impact of climate change on arid-zone birds in southern Africa and globally. The HBRP's research focuses mainly on birds in arid habitats in southern Africa, but also involves work in North America and Australia, and increasingly extends to habitats other than deserts.

Ten years of the Hot Birds Research Project

The HBRP came into being in mid-2009, when the late Prof. Phil Hockey and Andrew McKechnie spent two days brainstorming a new research programme on land birds and climate change. From humble beginnings consisting of three researchers at Tswalu Kalahari Reserve during the summer of 2009/10, the HBRP has grown into a team of about 20 researchers spanning three South African universities, SANBI and a number of overseas institutions. In its first decade, some 75 papers have emanated from HBRP research, and 35 MSc and PhD students have been trained, most of them funded by the Fitz Centre of Excellence. To celebrate the HBRP's 10th anniversary in 2019, the team held a three-day workshop at Gobabeb Research and Training Centre in the Namib Desert, where we took stock of current HBRP projects and the major questions that will drive our research for the next 10 years. One of the highlights was being joined at Gobabeb by Prof. Michael Kearney from U. Melbourne. Michael is an authority on modelling thermal landscapes and energy and water fluxes that occur between birds and their surroundings and has led the development of novel modelling approaches that hold great promise for predicting the vulnerability of birds to higher temperatures, highlighting critical knowledge gaps and allowing us to better target our field studies. Michael's time at Gobabeb allowed us to integrate biophysical models into several current hot birds projects.

Another important advance has been the development, led by Amanda Bourne and Celiwe Ngamphalala, of non-invasive techniques for measuring stress physiology and energy and water balance in free-ranging birds. Using study populations of habituated birds, we can now measure behavioural and physiological responses to high temperatures simultaneously. These techniques will allow us to ground-truth laboratory physiology measurements against

In July 2019 the Hot Birds Research Project team held a very successful workshop at Gobabeb Research and Training Centre in the Namib Desert to celebrate 10 years of hot birds research (Photo: Nick Pattinson).

comparable measures in free-living birds, letting us assess the impacts of captivity stress on these measures and improve our predictions of how species respond to high temperatures under natural conditions.

A number of continuing HBRP studies examine links between temperature, behaviour and fitness in desert birds and focus on how increasingly frequent periods of hot weather negatively affect the ability of adult birds to maintain body condition, as well as their capacity to breed successfully. These effects of rising temperatures drive declines in both adult survival and breeding success and have the potential to drive major declines in populations as their habitats become hotter. While less dramatic than large-scale mortality events, such as birds dropping dead from heat during the devastating Australian heat wave of December 2019, these sublethal consequences of chronic exposure to sustained hot weather are emerging as the major threat to southern Africa's desert avifauna. A risk assessment conducted by Shannon Conradie as part of her MSc and published in the *Proceedings of the National Academy of Sciences of the U.S.A.* in 2019 revealed that, in the absence of meaningful reductions in carbon emissions, the Kalahari of the late 21st Century will be too hot for our long-term study species: Southern Pied Babblers *Turdoides bicolor*, Southern Fiscals *Lanius collaris*, Southern Yellow-billed Hornbills *Tockus leucomelas*.

Heat dissipation behaviour – a global perspective

One of the longest-standing hot birds projects, which has been ongoing since 2009, focuses on whether readily-observable heat dissipation behaviours such as panting and wing-spreading can provide a quantitative index of species' vulnerability to rising temperatures. In addition to a large data set for Kalahari species, we have collected comparable data for bird communities in the Sonoran Desert of North America and the Gascoyne region of western Australia. During 2019, Nick Pattinson and a team of collaborators completed a global analysis on avian heat dissipation behaviour, and a manuscript based on this work was accepted by *Journal of Avian Biology* in December 2019. The late Phil Hockey is senior author on this paper, as he was the first to suggest that behavioural data requiring little more than binoculars and a thermometer to collect may provide an easily-quantifiable metric of susceptibility to negative effects of high temperatures on arid-zone birds.

Heat dissipation and foraging behaviour in Tankwa Karoo larks and chats

In 2019, the HBRP made its first foray into South Africa's most extreme desert: the Tankwa Karoo. CB MSc student Matthew Orolowitz spent October and November in the Tankwa, collecting data on the behavioural responses of the region's lark and chat species to high temperatures, and measuring the thermal landscape using black globe thermometers. Matthew investigated whether thermoregulatory behaviour could predict the strength of foraging trade-offs in the heat. He found that, among larks, drinking behaviour (i.e. whether birds made use of surface water sources or obtained their water from food) was the strongest predictor of the temperature at which birds retreated to shaded microsites and began panting. However, the reduction in foraging effort as temperatures increased was better correlated with body size (not drinking behaviour), suggesting that the apparent foraging-thermoregulation trade-off might not be mediated by shade-seeking and panting behaviours in these

A Spike-heeled Lark *Chersomanes albofasciata* in the desert landscape of the Tankwa Karoo. MSc CB student Matthew Orolowitz studied the impacts of body mass and drinking behaviour on the responses of several lark species in the Tankwa to high temperatures (Photo: Matthew Orolowitz).

birds. Matthew is writing up his dissertation and will submit his results for publication in 2020.

Red Larks – combining behaviour, physiology and modelling

PhD student Ryno Kemp completed his final year of data collection on the Vulnerable Red Lark *Calendulauda burra*. He focused on sublethal fitness costs during hot weather and how these differ between sexes. In addition, body mass data for habituated individuals weighing themselves every morning and afternoon have revealed important differences between males and females in terms of how daily maximum air temperatures affect body condition. These data provide the basis for modelling how warming temperatures will affect the species in coming decades. The picture that has emerged from this project is concerning, as male Red Larks will experience large increases in risks of chronic negative effects of hot weather. Ryno is also working on the home range data he collected to estimate the population size for Black Mountain Mine conservation area as well as a manuscript combining all the data to model the water and energy budget for Red Larks under current and future climatic scenarios.

PhD student Nick Pattinson inserts a temperature sensitive PIT-tag beneath the skin between the wings of an adult male Southern Yellow-billed Hornbill. Nick is monitoring body temperature regulation in hornbills during nest provisioning. (Photo: Amanda Bourne).

Climate change impacts on breeding success

Nick Pattinson and Ben Murphy began their PhDs in 2018 on Southern Yellow-billed Hornbills and Fork-tailed Drongos *Dicrurus adsimillis*at the Kuruman River Reserve in the Northern Cape. Both species are resident in the Kalahari Desert, and attempt to breed in spring and summer when resource abundance peaks. However, high resource availability coincides with high air temperatures, meaning that both species must handle severe heat stress during their breeding attempts. Previous studies on these species have shown effects of rainfall and heat stress on their ecology in the Kalahari. For the hornbills, 10 years of monitoring at this study site has revealed how increasing temperatures and decreasing rainfall drastically reduce breeding performance. Nick is using an experimental approach to disentangle the effects of temperature and resource availability to elucidate what is driving variation in hornbill reproductive performance. He is measuring physiological and behavioural responses to heat stress and variation in resource availability.

Ben is looking more specifically at behavioural responses to heat stress, and how they relate to breeding performance. Ben's work follows earlier research by the HBRP team suggesting that Fork-tailed Drongos may be a "Darwinian demon" – they seem to show no negative effects of heat-stress-driven reductions in provisioning on pre-fledgling condition or fledging probability. Ben uses an experimental and observational approach to investigate whether drongos buffer fledgling mass during the nestling cycle by altering foraging and provisioning strategies at high air temperatures. Additionally, Ben is examining whether drongos might mitigate offspring thermoregulatory costs through nest shading and is also exploring whether underlying physiological capacity to regulate body temperature during activity at high air temperature further defines parental behavioural strategies.

Krista Oswald submitted her PhD at Rhodes University on Cape Rockjumpers *Chaetops frenatus* in the Fynbos mountains. She concluded that Rockjumper populations are likely to see strong negative impacts from climate change, predominantly through reduced reproductive

A Cape Rockjumper provisioning nestlings. Krista Oswald submitted her PhD on how climate is affecting this montane specialist (Photo: Krista Oswald).

success. Rockjumper nests had greater chance of succeeding at low temperatures due to reduced snake activity, although nests in recently burned habitat also had higher success. Krista also found Rockjumpers have low overall genetic diversity, and so may show limited adaptive capacity to rapid environmental changes. Krista published one paper in *Animal Behaviour* in 2019, and she is back in Canada preparing more manuscripts from her PhD.

Can sociality buffer climate change impacts?

PhD student Amanda Bourne has been studying the ways in which cooperative social behaviour might buffer the fitness costs and consequences of exposure to high temperatures and drought, using Southern Pied Babblers as a model species. Pied Babblers are cooperative breeders with natural variation in group size, and are endemic to the hot and dry Kalahari. In 2019, Amanda completed her lab and field work and wrote the bulk of her thesis. She found that both successful reproduction and the probability of interannual survival are severely compromised during hot and dry weather, suggesting that this species may face population persistence challenges as climate change advances, bringing with it more frequent and hotter heat waves and droughts. Although Pied Babbler groups with more helpers often produce more surviving young overall, larger group sizes do not appear to moderate the effects of high temperatures and drought, suggesting that these conditions act on individuals via physiological tolerance limits and resource constraints. Amanda uses a combination of behavioural observations and non-invasive measurements of energy expenditure and water turnover to build a holistic picture of the mechanisms linking high temperatures and drought to fitness costs in these birds. One of her chapters was published in 2019, in *Functional Ecology*, and a further two chapters are currently under review, at *Ecology Letters* and *Proceedings of the Royal Society B,* respectively.

Non-invasive techniques

Handling stress may obscure the very signatures of environmental stress that the HBRP team is interested in, so finding less invasive ways to measure physiology in wild birds is an important research priority. The HBRP team have been developing and testing non-invasive methods for measuring physiological responses and this has resulted in publications in *Functional Ecology* and *General and Comparative Endocrinology*. Some of this research, led by Amanda Bourne, focuses on measuring metabolic rates and water turnover using a novel doubly-labelled water technique involving oral dosing and faecal sampling instead of the more traditional injecting and blood sampling. A proof of concept study has demonstrated that faeces provided an adequate substitute for blood as a source of body water, and both non-invasive dosing and non-invasive sampling proved feasible in the field.

Another part of this research, led by PhD student Celiwe Ngcamphalala, focuses on quantifying in glucocorticoid ("stress hormone") concentrations. This involves the validation of appropriate enzyme immunoassays (EIA) to quantify faecal glucocorticoid metabolites (fGCM) in four species. The use of fGCM analysis allows for non-invasive sampling by removing both the need to bleed birds and the need to catch or handle the birds to quantify stress responses, i.e. samples can be collected from free-ranging individuals. Using the assays validated by former HBRP Honours student Emma Jepsen, Celiwe and BTech student Lesedi Moagi have shown that stress responses to maximum daily temperatures vary between captive and free-ranging Southern Pied Babblers, which reinforces the importance of these non-invasive sampling techniques that can be applied in the birds' natural environment. without imposing capture or handling stress.

Variation in evaporative cooling capacity

Habitats vary widely in terms of the physiological challenges they pose to animals, and much remains to be learned about how the thermal physiology of birds has evolved in response to different sets of environmental variables. Current literature regarding avian thermoregulation in the heat is dominated by studies on species inhabiting hot, arid regions. As a result, our understanding of whether species residing in non-arid habitats are less, equally or possibly even more physiologically vulnerable to potential future increases in air temperature, remains limited. PhD student Marc Freeman aims to improve our understanding in this area through quantifying variation in avian evaporative cooling efficiency, heat tolerance and assessing the effect of increasing humidity in phylogenetically diverse avian taxa. The project will be conducted for multiple species within three climatically-contrasting biome types (desert, montane grassland, thicket and subtropical forests) representing a gradient of maximum air temperatures. One key variable Marc's research will focus on is humidity: even though maximum air temperatures in coastal forests are lower than those in deserts, high humidity is likely to severely curtail the capacity of birds to dissipate heat by evaporation. By the end of 2019 Marc had collected data from ~20 species inhabiting grasslands in the eastern Free State province, and January 2020 saw him continuing this work in the Richard's Bay area.

Climate change past, present and future

In 2019. Shannon Conradie registered for a PhD which expands on the findings of her MSc. Her work focuses on developing novel modelling approaches integrating the thermal landscape, heat and water fluxes and behavioural decisions and trade-offs for desert birds currently and under future climate change scenarios. Ultimately, her study will enable us to construct detailed models of survival and reproduction in birds, reducing the need for detailed species-specific empirical datasets to predict avian responses to climate change., Shannon spent time in the USA developing skills in biophysical modelling approaches and dynamic state variable models. Currently Shannon is working on refining

Research assistant Keegan Schoeman in the field investigating how heat tolerance varies across biomes and is affected by humidity, which has been the stimulus for a new hot birds project in the coastal forests of northern KwaZulu-Natal (Photo: Marc Freeman}.

Conservation Biology MSc student Matthew Orolowitz (left) and field assistant Eleanor Shadwell (right) search for larks in the empty landscape of the Tankwa Karoo National Park (Photo: Susie Cunningham).

these modelling techniques and validating model outputs with empirical data collected from the Kalahari Desert in Southern Africa.

Highlights:

- Our biannual workshop was held at Gobabeb in the Namib Desert to commemorate the 10th Anniversary of the HBRP. We were joined by collaborators Profs Michael Kearney and Blair Wolf, both of whom provided valuable input.
- A paper by Shannon Conradie and co-authors titled "Chronic, sublethal effects of high temperatures will cause severe declines in southern African arid-zone birds during the 21st century" was published in the prestigious journal *Proceedings of the National Academy of Sciences of the USA.*
- The HBRP published another 15 papers in international peer-reviewed journals in 2019.
- Susie Cunningham, Amanda Bourne, Nicholas Pattinson, Celiwe Ngcamphalala, Barry van Jaarsveld and Andrew McKechnie presented papers at the Australasian Ornithological Conference held in Darwin, Australia in July.
- Shannon Conradie and Mpho Malematja graduated with MSc degrees from the University of Pretoria.
- HBRP research was featured in a *Carte Blanche* insert on the effects of climate change on animals in the Kalahari; and in a radio interview with *Radio Sonder Grense.*
- HBRP collaborator Janet Gardner of the Australian National University in Canberra received a grant that includes funds for exchange visits by Amanda Bourne and Janet's PhD student, Lynda Sharpe.

Key co-supporters

DST-NRF CoE grant; SARChi Chair in Conservation Physiology, UCT URC, U. Pretoria; NRF Thuthuka Grant; NRF CSUR Grant, Tygerberg Bird Club.

Research team 2019

Prof. Andrew McKechnie (U. Pretoria, SANBI)
Dr Susie Cunningham (FIAO, UCT)
Dr Janet Gardner (Australian National University)
Dr Alex Gerson (U. Massachusetts)
Dr Alan Lee (FIAO, UCT, SANBI)
Dr Rowan Martin (FIAO, UCT)
Dr Todd McWhorter (U. Adelaide)
Dr Ben Smit (Rhodes)
Dr Zenon Czenze (U. Pretoria)
Dr Blair Wolf (U. New Mexico)
A/Prof. Amanda Ridley (U. Western Australia)
Dr Tom Flower (FIAO, UCT / Capilano University)

Students: Amanda Bourne (PhD, UCT); Shannon Conradie (PhD, Pretoria); Marc Freeman (PhD, Pretoria); Ryno Kemp (PhD, Pretoria); Benjamin Murphy (PhD, UCT); Celiwe Ngcamphalala (PhD, Pretoria); Matthew Noakes (PhD, Pretoria); Krista Oswald (PhD, Rhodes); Nicholas Pattinson (PhD, UCT); Michelle Thompson (PhD, Pretoria); Miqkayla Stofberg (MSc, UCT); Barry van Jaarsveld (MSc, Pretoria); Matthew Orolowitz (CB MSc, UCT); Lesedi Moagi (BTech, TUT); Andries Janse van Vuuren (Hons, Pretoria); Michelle Bouwer (Hons, Pretoria).

Research Assistants: Lauren Bailey, Jo Balmer, Shelby Bohn, Cameron Brock, Rachel Bucksey, Josephine Bruning, John Diener, Lizzie Diener, Carla Dodd, Gabe Foley, Samantha Fourie, Amy Hunter, Justin Jacobs, Rowan Jordaan, Craig Kenny, Danielle Keys, Noxolo Kinzela, Vuyiseka Mbiko, Sakhile Mkhize, Lesedi Moagi, Sophie Monsarrat, Angela Moreras, Ceili Peng, Anna Probert, Keegan Schoeman, Alyssa Stulberg, Jack Thorley, Alex Thouxeau, Amy Tipton, Samantha Wagstaff.

Global change and urban birds

Anyone who has spent time at the University of Cape Town will know about the Red-winged Starlings *Onychognathus morio* on Upper Campus. These birds have developed a reputation amongst the UCT community for being sly, lunch-thieving pests and many students can recount a story of having a starling swoop past their heads on Jammie Plaza in pursuit of a sandwich or some other treat. Since 2017 we have been conducting research on our favourite campus mascots, looking at how city-slicking birds cope with highly variable food quality and quantity in urban environments, the stresses of sharing their space with high numbers of people, and of high summer temperatures as Cape Town's climate warms.

Red-winged Starlings are an excellent example of a species that has taken advantage of the opportunities offered by urban environments. While many birds avoid urban areas due to disturbance, pollution, habitat transformation and other threats that they pose, some actively exploit cities. In their natural environment, Red-winged Starlings nest on cliffs in rocky and mountainous areas, but in cities they nest on buildings. Similarly, while they would normally feed primarily on fruit and insects, they have learned that cities offer rich opportunities for scavenging on anthropogenic food.

We aim to understand how Red-winged Starlings on campus cope with the opportunities and pressures of city life under climate change. One of the major themes of the project is to unpick the costs and benefits of a diet high in "junk food". In 2017 and 2018, MSc students Miqkalya Stofberg and Sarah Catto showed that adult starlings seem to benefit from easily-available anthropogenic food, gaining more body mass on weekdays than on weekend and vacation days when campus is quiet and food stalls are shut. Parent starlings feed both junk food and natural food to their nestlings, but provision a higher proportion of junk food on high human presence days. This junk food diet appears to be bad for the young birds: chicks that experienced more high human presence days during the nestling period were smaller and lighter at ringing age than those whose early development overlapped with public holidays and vacations. In 2019, Miqkayla Stofberg completed a supplementary feeding experiment designed to untangle whether these impacts on nestling growth were indeed due to the poor quality of a diet high in anthropogenic food. At the time of writing, Miqkayla is analysing the results of this work.

A Red-winged Starling nestling being weighed. Miqkayla Stofberg is using a supplementary feeding experiment to investigate the effects of a diet high in junk food on starling nestling growth and parental behaviour (Photo: Susie Cunningham).

In a linked study, University of Lund MSc student Johan Jensen examined blood samples from the same population to quantify fatty acid profiles of adult birds. He found large variation in fatty acid profiles among birds, but no evidence that these were linked to temporal fluctuations in anthropogenic food availability over weekend – weekday timescales.

Also during 2019, BSc Hons student Taylyn Risi mapped home ranges of colour-ringed starlings across campus, and using GIS technology calculated the proportion of these ranges that were covered by built-up, impervious surfaces. She showed that starlings with more built-up home ranges enjoyed higher foraging efficiency and were both heavier and larger than birds with more "natural" home ranges. These data suggest that higher quality birds are attracted to settle in more urbanised areas of campus.

Red-winged Starling "AG", fledged in 2017 and an adult in 2019, weighs herself (Photo: Susie Cunningham).

Finally, a team of undergraduate students led by Mila Truter and supervised by Prof. Res Altwegg carried out a 2nd year statistics project to understand whether starlings are able to recognise humans as individuals and provided evidence that they do. This result has enormous implications for how we conduct our fieldwork, highlighting the need to keep carefully separate the team members engaged in "threatening" activities such as capture of adults and nest access work, and those engaged in "friendly activities" such as behavioural observations and weighing of adults on top pan balances in return for a small food reward. Mila and Taylyn are now writing up their results for publication in 2020.

Activities in 2019

- The colour-ringed population now consists of 204 adults and 77 juveniles and subadults that were ringed between 2017 and 2019.
- The first generation of nestlings ringed in 2017 began to join the breeding population in 2019, with two females and one male attempting to breed for the first time.
- Taylyn Risi continued data collection on the birds outside the breeding season.
- Miqkayla Stofberg continued supplementary-feeding experiments looking at the impacts of anthropogenic food on parental behaviour and chick growth.

Highlights:

- Miqkayla Stofberg published the first paper from the project in *Urban Ecosystems.*
- MSc student Johan Jensen and Honours student Taylyn Risi graduated with their degrees.

Impact of the project

Studying a resident and high-profile population of starlings that are well-known on campus has allowed us to involve the wider university community in a citizen science project, making our research more visible and relevant. The accessibility of the project and its fieldwork has also resulted in an ideal training opportunity for younger students wanting to gain experience in behavioural research and bird observation/ handling under careful supervision. Through the help of such volunteers, the project has managed to collect a large volume of data in its first two years.

Key co-supporters
DST-NRF CoE grant; NRF-STINT South Africa-Sweden Research Collaboration.

Research team 2019

A/Prof. Arjun Amar (FIAO, UCT)
Dr Martin Andersson (MEEL, Lund University)
Dr Susan Cunningham (FIAO, UCT)
Dr Arne Hegemann (MEEL, Lund University)
A/Prof. Caroline Isaksson (MEEL, Lund University)
Dr Johan Nilsson (OIKOS office, Lund University)
Dr Petra Sumasgutner (FIAO, UCT)
Dr Hannah Watson (MEEL, Lund University

Students: Miqkayla Stofberg (MSc, UCT); Johan Jensen (MSc, Lund); Taylyn Risi (BSc Hons, UCT).

Research Assistants: Dr Sally Hofmeyr, Natasha Pindral, Mila Truter.

Volunteers: Adam Begg, Laura Figenschou, Tsilavo Razafimanantsoa, UCT Mountain and Ski Club, Olivia Venter, Vince Ward, and many others.

The ecology of urban raptors

Urban development is increasing across the globe and poses a major threat to biodiversity, which is often relatively low in human-modified landscapes. In fact, next to climate change, the United Nations considers urbanisation to be the biggest environmental challenge to the maintenance of biodiversity. Globally, there are now more people living in urban than in rural areas, and the trend towards urbanisation is faster in Africa and Asia than in any other regions of the world.

The Cape Peninsula is located on the southern tip of the African continent, where climate change is predicted to be particularly rapid and severe. In this project we focus on the responses of raptors to increasing urbanisation under climate change. On the Cape Peninsula, urban breeding Peregrine Falcons *Falco peregrinus* and Black Sparrowhawks *Accipiter melanoleucus* have been monitored over for 30 and 20 years, respectively. During this time, the populations of both species within the study area have increased markedly. Both species profit from the abundance of suitable nesting sites and their favoured avian prey, such as pigeons, doves and Common Starlings *Sturnus vulgaris*. We use these two long-term data sets on individually-marked birds to investigate the effects of urban-living and weather on breeding phenology, reproductive performance, survival, senescence and population trends.

A pair of mating Black Sparrowhawks. We found evidence of ageing in the reproductive performance of Black Sparrowhawks, but ageing did not differ across an urbanisation gradient (Photo: Colin Brown).

Beside habitat loss and fragmentation, wildlife in urban areas might also be negatively affected by altered bio-geochemical cycles and the introduction of novel urban stressors such as light, sound and chemical pollutants. Urban-exploiting or adaptable species that are able to make use of abundant resources in the short-term, might thus still suffer from other hidden costs of urban living which could undermine their long-term health and persistence in urban environments. We use the Black Sparrowhawk study system and a biomarker approach to investigate such possible health impacts. Taking small blood samples from adults and their offspring, we have quantified eco-physiological parameters such as immune assays, oxidative stress and dietary antioxidants. The eco-physiological component of this research has been carried out in collaboration with Lund University, Sweden, as part of a bilateral project funded by the NRF and STINT.

Activities in 2019

- In 2019 we ringed 34 Black Sparrowhawk chicks from 18 territories.
- Post-doc Petra Sumasgutner and PhD student Carina Nebel presented our research at the European Ornithological Union (EOU) Conference in Cluj, Romania.
- Together with Assoc. Prof. Caroline Isaksson from Lund University, Sweden, we continued the three-year joint NRF/STINT South Africa-Sweden research collaboration focusing on urban avian ecology. We commenced writing a review paper focusing on urban avian ecology.
- Dr Chima Nwaogu started a post-doctoral fellowship with the group. Part of his research is focused on understanding whether the immune system of Black Sparrowhawk chicks varies along the urbanisation gradient.
- In 2019 our research extended into another urban-raptor system. Rebecca Muller received a distinction for her Conservation Biology MSc

thesis, undertaken in collaboration with Dr Shane McPherson and Prof. Colleen Downs (UKZN). Rebecca unravelled the productivity of urban Crowned Eagles *Stephanoaetus coronatus*. A paper from this thesis is currently in review with the journal *Condor*.

- We submitted a paper to *PLoS One* on the influences of weather and urbanisation on Peregrine Falcon breeding success and phenology. The paper used Dr Andrew Jenkins' long-term dataset on breeding peregrines in Cape Town.
- BSc Hons student Kyle Walker analysed prey remains from Peregrine Falcon nests that have been collected over multiple years as part of Dr Jenkins' monitoring project. Kyle's dissertation explored how diet differs across the urban gradient and whether diet has changed from 20 years ago when Dr Jenkins first examined diet in this population.

Highlights

- Assoc. Prof Arjun Amar and Dr Juan Diego Ibáñez-Álamo co-organised a symposium at the EOU in Cluj, Romania, on "Urban ornithology: threats and opportunities" with Profs Dan Chamberlain and Peter Batary as key-note speakers.
- Arjun Amar, Chevonne Reynolds Dan Chamberlain and others published a paper on the Luxury Effect for South African bird richness in *Global Change Biology*.
- Petra Sumasgutner, Arjun Amar and volunteer Ann Koeslag published a paper in the *Journal of Avian Biology* entitled "Senescence in the city: exploring ageing patterns of a long-lived raptor across an urban gradient. The journal chose a photo of Black Sparrowhawks for their cover of that issue.

A light morph Black Sparrowhawk perches on a pine tree at the foot of Lion's Head. This species is very successful in urban habitats with some pairs breeding in suburban backyards (Photo: Paddy Walker).

Impact of the project

The project is one of the first to examine individual health and productivity of a bird species in relation to urbanisation in Africa. Our results have considerable implications for potential changes in phenology or productivity for the regions' avifauna as African urbanisation continues.

We assessed how diet differences between urban and 'rural' Peregrine Falcons might influence their demography, based on Andrew Jenkin's 30-year study of the Cape Town population (Photo: Andrew Jenkins).

Key co-supporters

DST-NRF CoE grant; NRF-STINT South Africa-Sweden Research Collaboration, Claude Leon Foundation.

Research team 2019

A/Prof. Arjun Amar (FIAO, UCT)
Dr Petra Sumasgutner (FIAO, UCT)
Dr Chima Nwaogu (FIAO, UCT)
Prof. Res Altwegg (SEEC, UCT)
Dr Andrew Jenkins (ADU, UCT)
Prof. Dan Chamberlain (U. Turin)
Dr Chevonne Reynolds (Wits)
Dr Arne Hegemann (MEEL, Lund University)
A/Prof. Caroline Isaksson (MEEL, Lund University)
Dr Hannah Watson (MEEL, Lund University)
Prof. Colleen Downs (UKZN)
Dr Shane McPherson (UKZN)

Students: Carina Nebel (PhD, UCT); Rebecca Muller (CB MSc, UCT); Kyle Walker (BSc Hons, UCT).

Research Assistants: Dr Shane McPherson, Burghen Siebert.

Volunteers: Ann Koeslag, Margaret MacIver, Antje and Bernard Madden.

Plastics in the environment

Plastics are used in a plethora of applications because they are lightweight, durable, have excellent barrier properties, and are relatively cheap. These properties also make inappropriately handled waste plastics a significant environmental threat. Plastic litter persists for many years, is readily dispersed by water and wind, and has been accumulating in the sea for decades. It entangles and is eaten by a wide diversity of marine fauna, killing them directly, or reducing their appetite. Concerns about 'microplastics' introducing persistent organic pollutants (POPs) into marine foodwebs, combined with the discovery of 'garbage patches' in all the main ocean gyres, has sparked renewed interest in the subject in the last decade or so.

Much remains to be learned about the threats that plastics pose to marine ecosystems, but we know enough to act to reduce the amount of waste plastic entering the environment. The most significant impacts of plastics on marine organisms arise from plastic ingestion, so it is important to understand why organisms ingest plastic. Tracking trends in plastic ingestion provides perhaps the best indication of the efficacy of mitigation measures introduced to reduce the amount of plastic in the oceans. However, it is not always feasible to sample plastic ingested by organisms, so we also monitor plastic in the environment, both at sea and washed up on beaches. Much of the recent research in this project has focused on understanding how plastics move through the environment, and how this affects estimates of plastic abundance.

Activities in 2019

- Vonica Perold started a PhD on seabird plastic ingestion, comparing plastics in seabirds over the last three decades with plastics available at sea.
- Eleanor Weideman finished sampling for her MSc on freshwater plastic pollution in the Orange and Vaal Rivers, and estimating macroplastic loads in three Cape Town storm water drains in relation to rainfall events. She will submit her thesis in early 2020.
- Vonica and Eleanor led a well-received project on sampling plastics at sea during the SEAmester at Sea cruise in July. The sampling opportunity added to Vonica's dataset on meso- and macro-plastic abundance off South Africa.
- In July-August, Vonica and Eleanor went on the winter SCALE cruise, sampling a transect south into the Southern Ocean, and collecting microplastics in newly-formed sea ice. Vonica also sampled plastics during the Gough Island relief voyage (Sep-Oct), and Eleanor led on sampling during the second SCALE cruise (Oct-Nov), when sea ice was again sampled at the end of the winter season.
- Applied Ocean Sciences MSc student Brandon Opie measured daily litter arrival rates at Milnerton and Koeberg beaches in winter, spring and summer, repeating previous studies conducted at these beaches by former MSc students in 1994/95 and 2012. Winter litter arrival rates have increased compared to the 1990s, but summer rates have decreased considerably at Milnerton, probably due to the deployment of a litter boom and other efforts to stem the flow of litter down the Black River.
- BSc Hons student Christie Munroe assessed selectivity among litter ingested by Sandy Anemones *Bunodactis reynaudi* in the intertidal at Muizenberg, based on monthly clean-ups run in conjunction with The Beach Co-op. She also conducted field experiments to determine the factors driving plastic ingestion in this species.
- BSc Hons student Elena Piller conducted a series of experiments to estimate sedimentation rates of buoyant plastic items across a salinity gradient. This project built on former CB MSc student Francesca Fazey's experiment, conducted solely in sea water, and found a strong seasonal signal in sedimentation rates as well as generally lower biofouling in freshwater systems.

- NOAA-funded PhD student Anna Robuck visited from the University of Rhode Island to sample plastics from Great Shearwaters *Ardenna gravis*, working with Vonica Perold.
- The first survey of seafloor litter off South Africa was published in a collaboration with Tracy Fairweather and Deon Durholtz, based on rubbish caught during the 2019 hake stock assessment survey.
- Peter Ryan chaired the WIOMSA Group of Experts on Marine Plastics and hosted the inaugural meeting of the group in Cape Town.
- Peter attended the second meeting of the Scientific Committee for the Ocean (SCOR) working group on floating debris (FLOTSAM), held in Utrecht, Netherlands, via Skype. This workshop resulted in a review paper on the physical and biological processes driving the transport of plastics in marine systems which is in press with *Environmental Research Letters*.
- Peter was invited to teach on UNEP's first "Train the Trainers" workshop designed to kick-start plastics monitoring programmes. Held in Mombasa, Kenya, in August, it was attended by country representatives from throughout the western Indian Ocean region. After the workshop, Peter sampled bottles and mesoplastics along the south-central Kenya coast.
- Peter also visited the Pitcairn Islands in Oct-Nov 2019 to assess the severity of the plastics 'problem' at these very remote islands. Henderson Island, the largest of the Pitcairn Islands, has been reported to be one of the most polluted islands in the world, yet the density of plastic at sea and on other islands in the group is modest, suggesting that Henderson Island is anomalous in accumulating high densities of floating litter.

Highlights:

- A paper on bottles washing ashore on Inaccessible Island, which identified Asian shipping as a major source of litter in the central South Atlantic Ocean, was published in the *Proceedings of the National Academy of Sciences of the USA*.
- A further four papers were published in 2019: two in *Marine Pollution Bulletin*, one in *Environmental Pollution* and one in *Elementa: Science of the Anthropocene*. Peter Ryan also was a co-author on the UN GESAMP report on monitoring marine plastics.
- Peter was contracted by the CSIR to write two of a suite of five review papers on marine plastics in South Africa planned for publication in the *South African Journal of Science* in 2020.
- Three papers arising from the ACE cruise were finalised, with two published in early 2020.

Bottles on De Hoop beach, where foreign water bottles from ships predominate. The black canister (back right) was made in 1974 (Photo: Peter Ryan).

Key co-supporters

Plastics SA, ACE Foundation; Swiss Polar Institute, South African Department of Science and Technology, through the Waste RDI Roadmap, managed by the Council for Scientific and Industrial Research (CSIR), Commonwealth Litter Programme (CLiP), United Nations Environment Programme, WIOMSA.

Research team 2019

Prof. Peter Ryan (FIAO, UCT)
A/Prof. Coleen Moloney (Biological Sciences, UCT)
Dr Maelle Connan (NMU)
Aaniyah Omardien (The Beach Collective)
Dr Stefano Aliani (CNR-ISMAR)
Guiseppe Suaria (CNR-ISMAR)

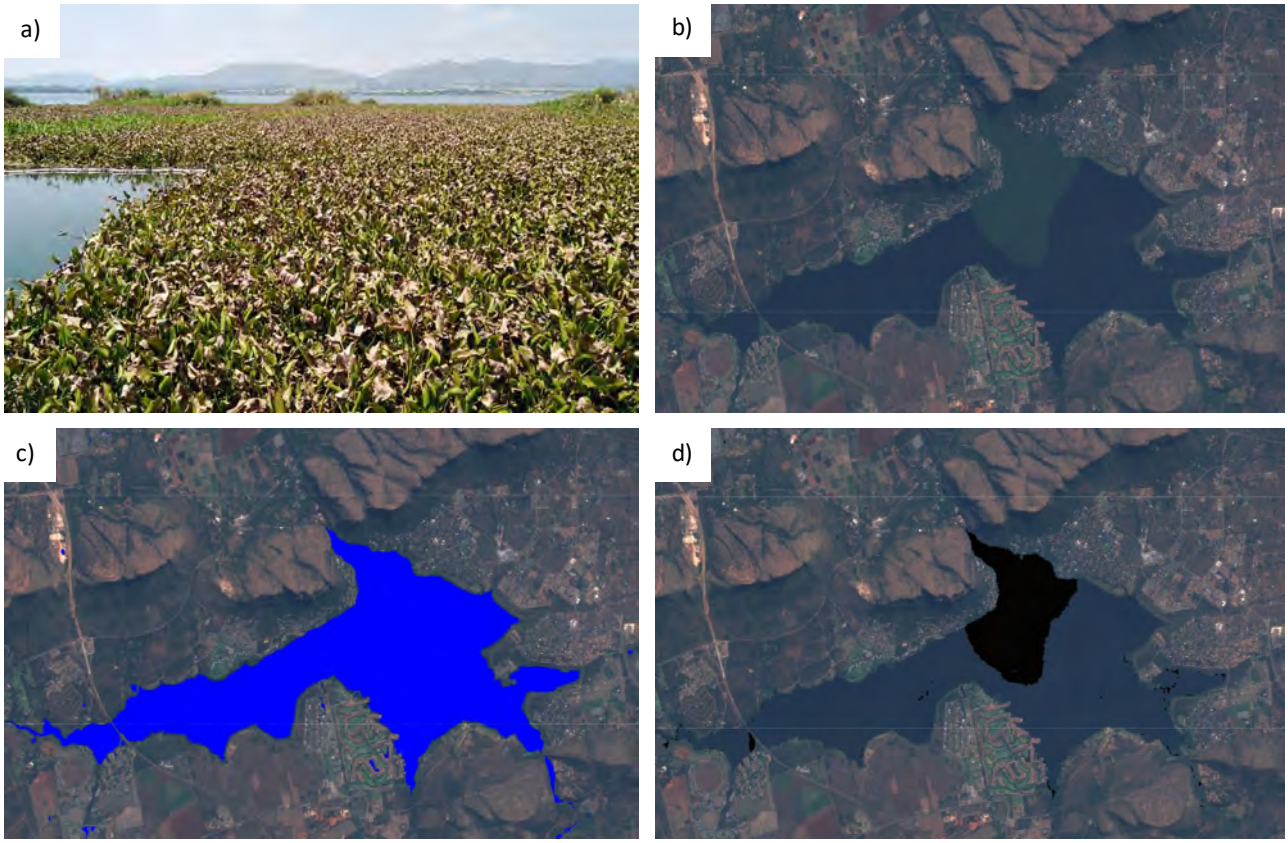
Students: Vonica Perold (PhD, UCT); Eleanor Weideman (MSc, UCT); Brandon Opie (AOS MSc, UCT); Christie Munroe (Hons, UCT); Elena Piller (Hons, UCT).

Detecting aliens from space

Biological invasions are responsible for some of the most devastating impacts on the world's ecosystems. Freshwater ecosystems are among the worst affected, with biological invasion posing serious threats not only to freshwater biodiversity, but to the important ecosystem services it provides. Tackling the impact of these invaders on our freshwater ecosystems is currently a major challenge, and one that requires detailed information on both invasive species distribution and spread. While these concerns are relevant globally, there is an urgent need to conduct research of this nature in countries such as South Africa, where freshwater resources are becoming increasingly pressured. This project utilises freely available satellite data and the processing capabilities of cloud computing platforms to map the distribution of invasive aquatic alien plant species across South African waterbodies and explore reasons for their spread. PhD student Geethen Singh is undertaking this valuable research in collaboration with Chevonne Reynolds, Benjamin Rosman and Marcus Byrne of the University of the Witwatersrand).

South Africa's surface water is frequently imaged by overpassing satellites. These valuable images can track water level changes from national extents down to individual dams. This provides scientists and water managers with near real-time monitoring of water resources. Invasive aquatic alien plant species present a serious threat to South Africa's freshwater resources as they increase water loss through evapotranspiration. Water weeds can increase water loss by 130–180%. Water body area and the percentage cover of invasive aquatic weeds on these impoundments are crucial information needed to facilitate the removal and management of these water weeds. However, field assessments to obtain this information are often too time-consuming, costly and labour intensive. Freely available satellite images are an alternative and cost-effective approach to reliably and frequently estimate the percentage cover of water weeds on surface water. In this way, the extent of water weed infestation and its associated drivers can be identified and tracked.

Once an invasive alien species has established itself it can be difficult or even impossible to stop or slow down the invasion. Thus, the early and rapid detection of invasive alien species is needed to make management targeted, feasible and effective. Consequently, there is an urgent need for techniques that enable consistent, fast and accurate monitoring. This will allow invasion biologists the unprecedented capability to systematically monitor invasive alien species over the introduction, establishment and secondary dispersal phases of the invasion process, across large areas with a reduced risk of accidental invasive alien plant dispersal by field personnel. Geethen is making use of semi-automated satellite image analysis techniques, such as semantic segmentation of freely available Landsat and Sentinel-2 imagery to map the distribution of five prevalent invasive aquatic plants at a national level. Furthermore, he is undertaking this analysis within Google Earth Engine, a cloud computing platform that allows scientists and managers the ability to produce up-to-date maps of invasive species distribution and percentage cover on a frequent basis. Geethen is also working towards an application so that these products will be readily available to managers and decision makers when they require them. Over the last year, Geethen has made excellent progress in discriminating between our top five worst aquatic invaders; Water Hyacinth, Water Lettuce, Parrots Feather, Kariba Weed and Red Water Fern. In collaboration with the Centre for Biological Control at Rhodes University, who provided valuable ground-truthing data for these species,



Water Hyacinth infestation at Hartebeespoort Dam in Johannesburg (a); Hartebeesport Dam viewed from an over passing satellite (b); Accurate mapping of the entire waterbody and used to limit the classification of vegetation to only the dam (c); Accurate mapping of the moving Water Hyacinth mat on Hartebeesport Dam (d).

Geethen has been able to produce accurate and robust predictions of aquatic vegetation and its subsequent discrimination across South Africa. In the coming months Geethen will be investigating how other satellite-derived data products can provide information on biotic and abiotic drivers of these alien invasive species distributions. This will include using satellite telemetry data of southern African waterbirds to assess the contribution of this little considered vector in invasive species spread. With the ability to identify the dominant drivers within regions comes the ability for managers to tailor more effective strategies to combat invasive populations.

Activities in 2019

- Geethen began prepping a manuscript on the distribution of invasive aquatic alien species.
- Geethen and Chevonne attended the National Symposium on Biological Invasion in Cape Town and a Google Earth Engine workshop in Stellenbosch.
- Geethen attended a workshop on Synthetic Aperture Radar (SAR) at Wits rural facility and a Deep Learning Indaba in Durban.
- Geethen organised and presented three tutorials and two workshops based on the analysis of geospatial data for staff and students of Wits University.

Highlights:

- Geethen upgraded his MSc research to PhD.
- He has been able to map and discriminate aquatic vegetation at state-of -the-art accuracies for five invasive aquatic alien plants across the largest extent (national scale) for the longest period (5 years).
- Geethen has been approached to develop and teach geospatial techniques at Wits University.

Key co-supporters

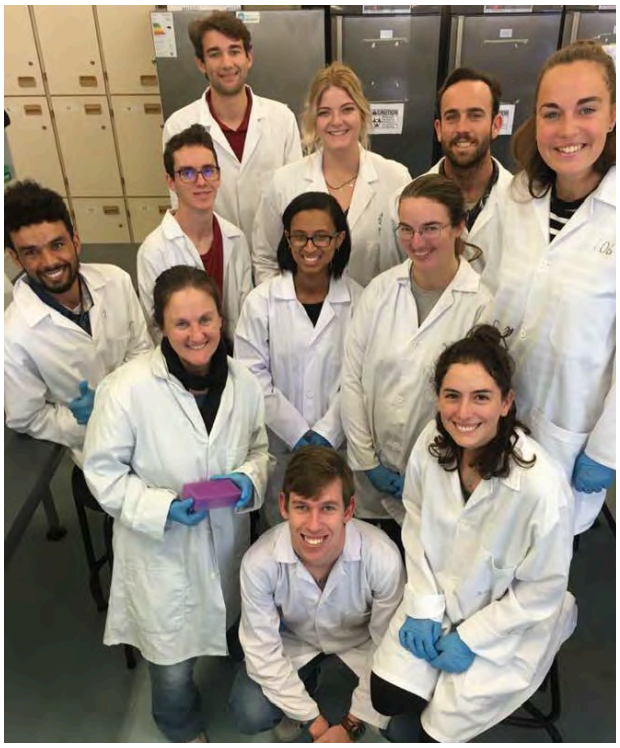
DST-NRF CoE grant.

Research team 2019

Dr Chevonne Reynolds (APES, Wits)
Dr Benjamin Rosman (Applied Maths, Wits)
Prof. Marcus Byrne (APES, Wits)

Student: Geethen Singh (PhD, Wits)

Conservation Biology Masters programme 2019



The 2019 CB class in the lab during the Conservation Genetics module (Photo: Jacqui Bishop).

The 2019 intake of CB students comprised 11 students from South Africa, Mexico, the USA, the UK, Cape Verde and Zimbabwe. This diverse group also included the first ever student to enrol in the course part-time. Debbie Stanbridge balanced new motherhood with the stringent academic demands of the course incredibly successfully: completing over half of the coursework modules in 2019 and carrying out her project work as well. She will join us again in 2020 to mop up the remaining modules and the field camp. The 2019 cohort was again an extremely strong group academically, with seven students achieving distinctions in the coursework component. At the time of writing, the class are busy completing their dissertations for submission by 10 February 2020.

The next cohort of students which arrived in mid-January 2020, comprises 12 new students from ten countries: South Africa, Australia, India, Malawi, Mauritius, Tanzania, the UK, the USA, Zambia and Zimbabwe.

Course structure and teachers

The course continues to be taught by a wide range of module leaders from within and outside UCT. In 2019, the module leaders were David Cumming (Big Picture and Philosophy of Science); Wendy Foden (Conservation Leadership); Susie Cunningham (Biodiversity Basics); Robert Thomson (Community Ecology); Arjun Amar (Statistical Analyses and Project Planning); Sebataolo Rahlao and John Hoffman (Invasion Ecology); Colin Attwood (Marine Conservation); Guy Balme and Justin O'Riain (Conservation in Practice); Chevonne Reynolds and Hayley Clements (Landscape Ecology and GIS); Jeremy Shleton (Freshwater Conservation); Dalton Gibbs (Urban Ecology and Conservation); Jane Turpie (Resource Economics); Gladman Thondhlana (Conservation and Society); Claire Spottiswoode (Project Planning); Peter Ryan (Demography and PVA); Lindsey Gilson (Climate Change); and Jacqui Bishop (Conservation Genetics). In addition, many others contribute through guest lectures, field trips and discussions. This diversity of perspectives adds greatly to the course.

Challenges and opportunities

Home Affairs regulations continue to cause problems for international students, mostly related to extremely long delays in obtaining study visas. Two Zimbabwean students who were offered and accepted places on the course for 2019 had to defer their places due to this. On the positive side, the coursework modules continue to be highly rated by the students and new module leader Jeremy Shelton gained acclaim for the enthusiasm and energy he brought to the Freshwater Research module. Overall, we remain committed to offering a balanced programme exploring the social and ecological aspects of Conservation Biology, and to producing world class graduates in this field.

Highlights

- Research carried out by CB MSc students for their dissertations continues to produce publication-quality results. In 2019, at least four papers directly arising from CB projects were published or accepted for publication in local and international journals. We are excited that our CB students' research is being disseminated widely and can improve conservation outcomes in Africa and globally.
- The 2019 class also raised the profile of the course on social media, initiating Instagram and Facebook accounts for the course.

MSc Conservation Biology projects 2019

Brink, Rene: How well do buffer circles capture the ranging behaviours of territorial raptors? (Supervisors: Arjun Amar, Megan Murgatroyd)

Cerrilla, Cecilia: Population crash of an endemic South African cyprinid: the role of non-native fish, drought and other environmental factors. (Supervisors: Jeremy Shelton, Cecile Reed, Bruce Paxton)

Eastment, Conor: How has woody vegetation changed in north-east Namibia in response to land use, climate and fire? (Supervisors: Lindsey Gillson, Glynis Humphrey, Timm Hoffman)

Gardner, Kathryn: Patterns in abundance and composition of invertebrates in Table Mountain National Park Marine Protected Area. (Supervisors: Alison Kock, Colin Attwood)

Gedert, Jennifer: Calling ecology of micro frogs (*Microbatrachella capensis*): a case study using acoustic spatial capture recapture. (Supervisors: John Measey, Res Altwegg)

Harper, Jack: Assessing the climate change vulnerability of reptile and amphibian species found in Table Mountain National Park. (Supervisors: Susie Cunningham, Wendy Foden, Nicola van Wilgen)

Montrond, Gilson: Assessing sea turtle, seabird and shark bycatch in artisanal, semi-industrial and industrial fisheries in the Cape Verde Archipelago. (Supervisors: Peter Ryan, Rima Jabado, Ross Wanless)

Orolowitz, Matthew: Life on the edge: does body size influence how birds deal with the heat in South Africa's most extreme desert? (Supervisor: Susie Cunningham)

Sheridan, Kate: Human safety and shark conservation: an analysis of surfer risk perceptions and attitudes towards shark management. (Supervisors: Justin O'Riain, Nicoli Natrass)

Stanbridge, Debbie: Genetic admixture of Kruger National Park black rhino (*Diceros bicornis minor*): conservation implications. (Supervisors: Justin O'Riain, Nikki le Roex)

Wilson, Luke: Elephant impacts on woody vegetation around artificial waterholes in Zambezi National Park, Zimbabwe. (Supervisors: Timm Hoffman, Angela Ferguson, David Cumming)

Members of the CB class at the #FutureForFriday #ClimateStrikeCapeTown march to parliament in March 2019. It was great to see so many passionate young people out in Cape Town protesting for more governmental action in tackling climate change! (Photo: Kate Sheridan).

Niven Library

Collection Development and Donations:

We are very grateful for the more than 300 books donated to the Niven in 2019. Most came from well-known author, Ian Sinclair, who spent several years at the Fitz in the late 1970s, and who donated his extensive library to the Niven. Alumni Kari Gunson and Michael Mills also donated books they had authored and author, Tim Dee, who spent many afternoons in the library working on his book, *Landfill*, donated a copy to the Niven. We are also grateful to Kim Stevens and the Witwatersrand Bird Club for their donations.

Surplus books sold on the Niven book sale generated just under R6 000, which will go back into developing our collection. The Library purchased 11 books in 2019, and obtained two books as review copies. Funds raised also were used to bind volumes of journals which are not available electronically.

Phelisa Hans, the Niven Library Assistant, continued to digitise student theses and Biological Sciences Honours projects as well as the Richard Brooke reprint collection. We congratulate her for passing her courses and entering her final year of studies towards a degree in Library and Information Science with the University of the Western Cape.

Archival collections became a key focus in 2019. The Library received the Phil Hockey archive and Phoebe Barnard's data files. Sorting of the Phil Hockey archive is nearing completion and we look forward to making the inventory to this collection available to researchers.

Library Use and Requests for Information:

The Niven was used for 43 presentations, lectures, meetings and seminars during 2019. The Peter Steyn egg collection was viewed by Fine Arts students and used as inspiration for their projects.

The librarian, Janine Dunlop, received hundreds of requests for literature information from all over the world, supplying PDFs of papers and chapters to enquirers. Searches for article DOIs, calculation of *H*-indices, citation information, links to papers, journal impact factors, interlibrary loan requests, nest record cards, and other general requests were received.

Into the digital age:

Various initiatives were launched this year to bring the library into the digital age:

Tim Dee's book *Landfill* (Little Toller, Dorset)

1. **Online theses**

   To enable electronic access via the Niven online catalogue to all FitzPatrick Institute student theses, links were added to the catalogue records of 140 Honours projects and Masters and Doctoral theses produced between 2008 and 2017. This project is ongoing and involves collaboration with UCT Libraries' theses and dissertations repository, OpenUCT.

2. **Research data management**

   A research data management workshop was run to introduce Fitz students and their supervisors to the concept of managing, storing and sharing their research data. Fitz staff and students initiated the process of depositing research data sets, often associated with published scientific papers, into the UCT Library data repository system called "ZivaHub". The system is a facility of the Figshare research data management and dissemination platform which is an online open access repository where researchers can preserve and share their research research data and offers a https://doi.org number as an electronic link to the data set. Natalie Simon from the UCT Research Office published an article 'Goosing around on golf courses' on the research based on the dataset titled 'Goose vigilance and group size on golf courses in Cape Town' which was included in the 2018-2019 UCT eResearch Report to showcase datasets published on ZivaHub to promote the culture of open science at UCT.

The Niven catalogue record of a Fitz Master's thesis, including a link to the full text on OpenUCT.

3. New paper alerts

While the noticeboards in the Fitz foyer continue to be used to display the latest scientific papers and popular articles authored by Fitz staff and students, email notifications are now also distributed, with article authors, title, and DOI included for those who would like to download a paper of interest to them.

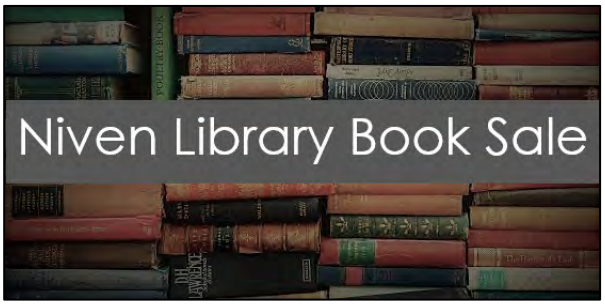
4. Niven new arrivals

Email notifications are also distributed when new books or journals are added to the collection.

Many of the journals to which we subscribe are no longer being distributed in hard copy. While our Current Journals section, where the latest copies of journals are displayed, remains popular amongst our staff and students, it is no longer a true reflection of our journal subscriptions. The focus, therefore, has been to ensure that library users are made aware of the latest issues of journals by distributing their contents pages via email. This entices users into the Library, and hopefully inspires them to write their own scientific papers. The journal catalogue records have also been edited to more accurately reflect our holdings and make access simpler.

5. Book sales

The Niven book sale went online this year, with the list of books and their prices being added to the Niven pages of the Fitz website. An online banner was created to advertise the sale, and weekly and monthly promotions were featured on both the website and the Fitz Facebook page.



Over the next few years, the focus in the Niven will be to enable electronic access to more of our collection, to make discoverability of our materials simpler and more intuitive, and to preserve valuable and well-used journals only available in hard copy. In this regard, selected journals only available in hard copy will be bound to ensure their preservation so that they remain intact and available for students and staff in the future.

Electronic access will be facilitated for those who are away from the office, either on fieldwork or other activities. This will be achieved through email notifications, the distribution of material via email, digitisation-on-demand, digitisation projects, and the regular updating of relevant catalogue records. Digitisation of our theses has been in full swing over the past two years and the plan is to extend this work to parts of our archival and map collections, as well as selected historical photographs.

SAFRING report

SAFRING, the South African Bird Ringing Unit, administers bird ringing within southern Africa, and to some extent throughout the rest of Africa, supplying rings and services to volunteer and professional ringers. SAFRING curates all the southern African ringing records digitally and maintains a close relationship with other ringing schemes internationally. It performs a critical function for bird research in Southern Africa and throughout the rest of Africa.

Although the first ringed bird (a White Stork *Ciconia ciconia*) was recovered in South Africa in 1909, the first birds were only ringed in southern Africa in 1948, under the auspices of the Southern African Ornithological Society. In 1973, bird ringing outgrew its amateur origins, and was taken over by the CSIR (Council for Scientific Industrial Research). Originally dubbed NUBRA, the National Unit for Bird Ringing Administration, SAFRING was housed at the Fitz until the late 1980s, when it was taken over as part of the fledgling Avian Demography Unit (ADU, later to become the Animal Demography Unit). Director Prof. Roy Siegfried envisaged the Fitz as an academic institute, equivalent to the Edward Grey Institute at Oxford University, and thought that bird ringing belonged in a monitoring unit similar to the British Trust for Ornithology. Sadly, it became increasingly difficult for the ADU to secure funds to support a full-time ringing administrator, and in 2017 the Fitz was asked by UCT to take over the running of SAFRING. Given the lack of dedicated funds towards this task, it was decided that the day-to-day running of SAFRING be devolved to the Niven Librarian, with the assistance of an NRF-funded intern and a Fitz academic in the role of coordinator.

New Niven Librarian Janine Dunlop and NRF-intern Kim-Kelly Hunt joined the SAFRING team in 2019 and have provided incredible support for the scheme and ringers. The year proved another consolidation year in terms of finances and ring stocks. Firstly, the purchase of existing ADU stock cost SAFRING R246 000 (as opposed to the R190 000 reported previously). The remaining bridging funding that was provided by the Fitz was used to purchase stock for ring series that were depleted. During the year a total of 118 000 rings were ordered. Rings sold to ringers during 2019 raised some R66 000, boosted by ringing projects being initiated in The Gambia and Guinea Bissau. Ring sales therefore generated income and the final balance sheet at year-end was R97 723.81, pending the 2019 repayment of R50 000 to the Fitz.

Facebook post: "A Wandering Albatross was caught on camera and, through a series of conversations between SAFRING and the photographer, and careful scrutiny of the band, SAFRING was able to identify it: This Wandering Albatross was banded as a chick on Marion Island, sub-Antarctic Indian Ocean in July 2016. Here it is 2 yrs, 9 months, 13 days later at the back of our boat off Tasmania. Thanks @safring_adu for the banding details!"

An Amur Falcon that survived the Mooi River hailstorm on 9 March 2019 in which 712 falcons were killed, was ringed by Rina Pretorius. It managed to migrate across the Indian Ocean, only to be captured in India. According to the Forest Department, the bird was trapped by two boys from a nearby jungle. The parents, after seeing the ring, delivered the bird to the forest officials. The falcon was kept in their custody for two days and then released in the Poba Reserve forest, 4 km from Jonai town on 19 May. The forest officials got in touch with SAFRING and we were able to connect the dots back to South Africa. The image is a still from a video of the recapture sent to SAFRING.

During the year we received news that Sir Clive Elliott, the first bird-ringing coordinator of SAFRING (then called NUBRA) had left a bequest to SAFRING of approximately R90 000 to be used by SAFRING for the broader 'bird ringing project' in South Africa. Sir Clive passed away on 18 April 2018 after a battle with cancer. He had a long association with SAFRING and the Fitz, being the third PhD to graduate from the Fitz. We are truly grateful to Sir Clive, his widow Lady Marie-Thérèse and his family for the donation, which is incredibly valuable and helpful to SAFRING.

In research, SAFRING published a summary of the biometric data for the majority of birds occurring in southern Africa. All electronically captured ringing records in the SAFRING database served as the foundation for this summary, a testament to decades of bird ringing in the region. The 2017 SAFRING ringing report was published in *Biodiversity Observations* during the year, while we are working on compiling the 2018 and 2019 reports.

Highlights

- Sanjo Rose, Dieter Oschadleus, Robert Thomson and Alan Lee published an article that used SAFRING data collected by thousands of bird ringers to summarize the biometrics of 694 southern African bird species.
- Led by Dane Paijmans, the SAFRING ringing report for 2017 was published in *Biodiversity Observations.*

SAFRING team 2019

Dr Robert Thomson (Co-ordinator, FIAO, UCT)
Janine Dunlop (Niven Librarian, FIAO, UCT)
Leigh Kelly (NRF Intern, January-March)
Kim Kelly Hunt (NRF Intern, April-December)
Michael Brooks (FIAO, UCT, SAFRING website maintenance)
Nosipho Mali (ADU, SAFRING website maintenance)

Research team 2019

Dr Alan Lee
Dr Dieter Oschadleus
Dane Paijmans

Southern African Bird Atlas Project (SABAP2)

The Second Southern African Bird Atlas Project started in mid-2007 and has collected over 18 million bird sighting records over the last 12 years. The data are collected primarily by citizen scientists and form the largest single dataset for birds in Africa. SABAP2 falls under the umbrella protocol of the wider BirdMap project, which is active in numerous countries in Africa, providing a single robust protocol and dataset for use in research across the continent.

Initially housed in the Animal Demography Unit, in January 2018 SABAP2 was moved, along with the Coordinated Waterbird Counts project (CWAC), the Coordinated Avifaunal Roadcount (CAR), SAFRING and the Virtual Museums, to fall under the Fitztitute. SABAP2 is managed by a committee chaired by Prof. Peter Ryan, with members from the University of Cape Town (Fitz and Centre for Statistics in Ecology, the Environment and Conservation (SEEC)), South African National Biodiversity Institute (SANBI), BirdLife SA, BirdLasser and citizen scientists. Day-to-day management of the project is led by Ernst Retief (BirdLife SA), with technical support from Michael Brooks and communications/outreach by Sanjo Rose. All SABAP2 data are uploaded to GBIF weekly. To date, SABAP2 data have been downloaded 7 922 times.

2019 saw the launch of the new SABAP2 website, designed to streamline data maintenance, and to allow greater data access by end-users and observers. We also started a much-needed update to the software that processes the incoming data and have re-designed the feedback mechanisms to the observers. This is due for launch early in 2020.

A total of 3.23 million records were added to the dataset across all protocols. This was collected by 989 observers, covering 5 476 pentads in the SABAP2 extended region (South Africa, Lesotho, Eswatini, Namibia, Botswana, Zimbabwe, Zambia, Mozambique). This represents an increase of approximately 15% to the complete dataset.

There are six regional subprojects in South Africa aimed at reaching specific atlas targets. The sub-projects play an important role in motivating atlasers by providing attainable local goals. The current subprojects are in the Western Cape, Free State, Mpumalanga, Gauteng, and the Eastern Cape. Each sub-project has a local coordinator who manages the atlasing effort and performs the data checks.

There were three formal atlas bashes in 2019. These bashes are typically a few days in duration and aim to increase data coverage in poorly atlased regions or to contribute to the atlas subprojects. The 2019 bashes focused on improving coverage around Atherstone Nature Reserve in Limpopo (50 pentads), Boegoeberg Dam in the Northern Cape (14 remote pentads) and Harrismith in the Free State (26 pentads). Bashes also help to build and maintain connections between atlasers.

BirdLife SA's bi-monthly magazine, *African Birdlife,* has a page dedicated to SABAP in each issue, which highlights project news, participant interviews and data use. Dr Chevonne Reynolds assists the management team in sourcing and editing stories. New servers were procured and installed. These were funded by generous donations from BirdLifeSA and the Western Cape Birding Forum. We also thank Prof. Les Underhill and the JRS for funding two additional servers to further upgrade our capacity into the future.

Data submitted by protocol during 2019

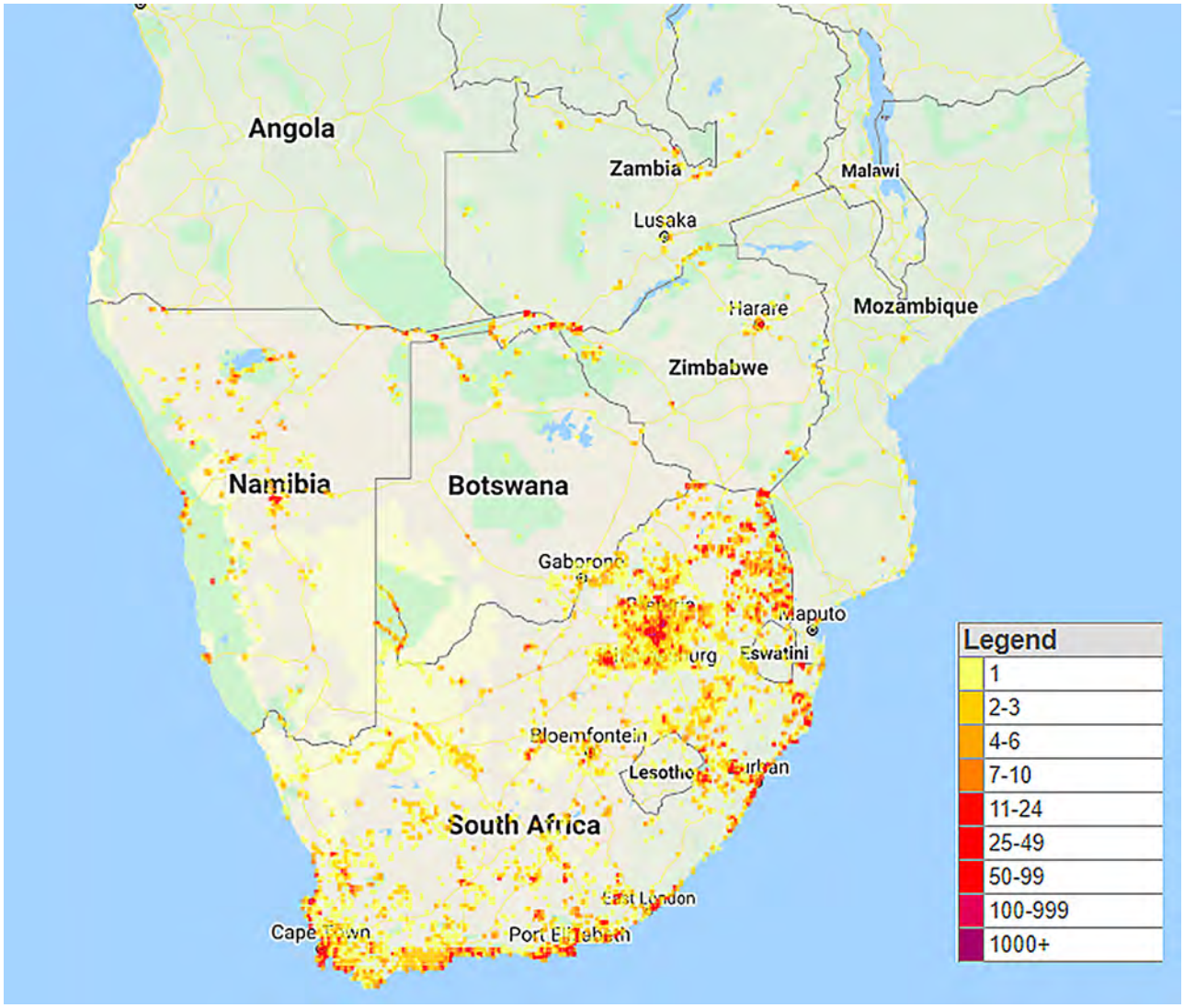
Protocol	Records
Full protocol*	1 491 410
Adhoc protocol (lists of less than 2 hours)**	438 491
Incidental and Additional Information records **	1 300 534

*Full protocol cards are used for distribution, phenology and to calculate reporting rates.

**Ad hoc cards, Incidental and additional information records are used for distribution and phenology only.

Summary of data submitted on Full Protocol cards

Country	Observers	Records	Pentads
Botswana	51	15607	162
Lesotho	21	1250	31
Malawi	2	899	14
Mozambique	36	6522	70
Namibia	114	63524	486
South Africa	791	1292259	4198
Eswatini	18	2761	22
Zambia	18	16348	130
Zimbabwe	58	31552	166



The number of full protocol cards submitted per pentad for SABAP2 in 2019. Although focused on population centers, there was significant effort in remote areas of the Northern Cape.

2019 publications utilising SABAP2 data

A list of the 12 papers published in 2019 that utilised SABAP2 data is available at http://sabap2.birdmap.africa/media/bibliography#pgcontent.

SABAP2 team (Admin)

Ernst Retief (Project Coordinator BirdLife SA)
Sanjo Rose (Project Communications, FIAO)
Michael Brooks (Information Systems Specialist, FIAO)

SABAP2 team (Regional Atlas Committees)

Carl Beel, Eastern Zambia
Jeff Curnick, Eastern Cape
Dawie de Swardt, Free State
Joe Grosel, Limpopo
Andrew Hester, Western Zambia
Peter Lawson, Mpumalanga
André Marx, Gauteng & Northwest
Bob Medland, Malawi
Vincent Parker, Northern Cape
Colin Summersgill, KZN
Chris Brewster, Botswana
Andrew de Blocq, Western Cape
Ian Gordon, KwaZulu-Natal
Doug Harebottle, Northern Cape
Holger Kolberg, Namibia
Etienne Marais, Mozambique
Duncan McKenzie, Mpumalanga
Ara Monadjem, Eswatini
Ian Riddell, Zimbabwe
Dave Winter, Western Cape

CWAC, CAR and the VMs

Coordinated Waterbird counts (CWAC)

The Coordinated Waterbird Counts project (CWAC) was launched in 1992 as part of South Africa's commitment to international waterbird conservation. It consists of regular counts of all waterbirds at a large number of South African wetlands, typically with at least two counts per year (one in summer and one in winter). As with SABAP2, CWAC counts are conducted by volunteers; people and organisations with a passion for waterbird conservation. It is one of the largest and most successful citizen science programs in Africa, providing much needed data for waterbird conservation. Currently the project monitors over 400 wetlands around the country, and curates waterbird data for over 600 sites, including wetlands in Kenya.

CWAC data are uploaded to the Global Biodiversity Information Facility (GBIF), the IWC and AEWA as part of South Africa's commitment to these important programmes. To date there have been 6431 downloads of the CWAC dataset/or parts thereof from GBIF.

In 2019, the CWAC continued to build on the 27 years of waterbird count data collection. A total of 378 surveys at 160 sites were conducted throughout South Africa. 153 species were surveyed, counting 634,016 birds.

The birds of Langebaan Lagoon, West Coast National Park, were counted for the 44th successive year, with summer and winter counts dating back to 1975. We thank Brian Van der Walt and Dave Whitelaw for their contribution to this massive dataset, having participated since the very beginning. Other notable long-term counters include Prof. Les Underhill, Dr Rene Navarro and Peter Nupen. For the last few years, Linda and Eddie Du Plessis have assisted with the coordination of CWAC, and we thank them for their efforts and enthusiasm for the project. Sadly, Eddie passed away in 2019.

Coordinated Avifaunal Roadcounts (CAR)

The Coordinated Avifaunal Roadcounts project started in 1993 with the aim of monitoring Blue Crane and Denham's Bustard populations. The project grew to include a list of 36 large and conspicuous bird species. CAR counts take place twice a year (mid-summer and mid-winter) across South Africa along set road routes. In 2019, birds were counted along 98 routes.

2019 CWAC surveys by province

Province	Sites	Surveys	Species	No of birds
E Cape	7	15	79	18052
Gauteng	45	89	94	68796
KZNl	18	26	95	17560
Limpopo	7	13	72	5304
Mpumalanga	4	7	75	7254
North West	5	8	71	11506
N. Cape	4	8	43	9257
W Cape	70	212	110	496287
TOTAL	160	378	153	634016

2019 CAR surveys by province

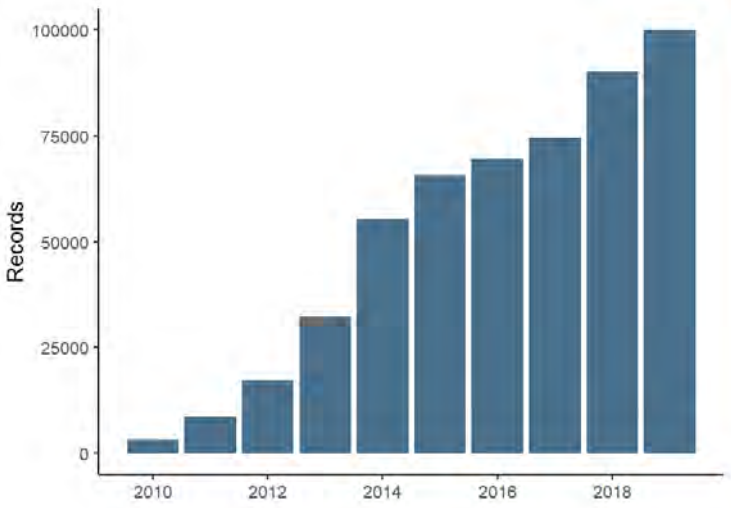
Province	Number of routes	Number of species
Western Cape	36	22
Eastern Cape	11	23
Free State	28	30
Gauteng	12	19
Kwazulu-Natal	12	22
Mpumalanga	9	22

Some project participants have submitted a summary of the population trends from their routes to the special citizen science edition of *Ostrich*. The data also have been used in several conservation assessments, and formed the basis of Dr Sally Hofmeyr's PhD.

Virtual Museum (VM)

The Virtual Museum (VM) is a database system and web front-end designed to provide a platform for citizen scientists to contribute to science-driven biodiversity projects. A key advantage over competing databases is that submitted records are identified and vetted online by a panel of experts. Taxon-specific VMs serve as repositories for the long-term curation of distributional data sets. These data are made freely available in the form of maps and lists through the internet. VMs have been used as the platform for national Conservation Assessments of reptiles, butterflies, mammals and birds.

Established by the Animal Demography Unit (ADU) in 2005 as part of the Southern African Reptile Conservation Assessment, the VM platform was cloned in 2007 to be used in the Southern African Butterfly Conservation Assessment. Maintaining and developing parallel platforms was a challenge, so in 2010 a new multi-project VM-platform was launched, which has been continuously enhanced and it is still in use today. In 2017, the then Dean of the Faculty of



The steady growth in the number of records uploaded by Citizen Scientists each year over the last decade across all VM projects

Science, Prof. Anton le Roex, asked the Fitz to negotiate with the ADU to provide a long-term home for the ADU databases, including the VMs, SABAP, CAR, CWAC and SAFRING. This was mainly contingent on finding funding to cover the salaries of the two data managers responsible for maintaining these databases. Fortunately, two-years of funding support was provided by DEA, through SANBI, to sustain the projects from March 2018 to February 2020, and from 1 January 2018 they were moved to the Fitz.

Currently the VM hosts 17 biodiversity projects: BirdPix (bird pictures archive); BOP (odd plumages of birds). PHOWN (photos of weaver nests), and 14 atlases: DungBeetleMAP (dung beetles, Coleoptera: Scarabaeidae). EchinoMAP (African Echinoderms: sea stars, sea urchins and brittle stars), FishMAP (freshwater fish in southern and eastern Africa), FrogMAP (African frogs), LacewingMAP (African Neuroptera and Megaloptera), MushroomMAP (South African mushrooms), OdonataMAP (African Odonata), OrchidMAP (African orchids), LepiMAP (African Lepidoptera), ReptileMAP (African reptiles), ScorpionMAP (African scorpions), SpiderMAP (African spiders), MammalMAP (African mammals), and TreeMAP (South African trees).

Project manager, Rene Navarro, also maintains RePhotoSA for the Plant Conservation Unit, and is helping to set up a citizen-science platform for Prof. Claire Spottiswoode's honeyguide group; he also processes data requests for the VM, CAR and CWAC.

The VM has proven to be a very successful tool for collecting occurrence data across most projects and despite the lack of project-specific facilitators, there has been steady growth of the total number of records uploaded by citizen scientists. The VM currently holds about 1.1 million open access records (48.8% contributed by citizen scientists), and another 0.7 million non-sharable records.

2019 publications

Three papers were published in *Biodiversity Observations* during 2019.

Project manager and developer:
Dr René Navarro

Project coordinators:
BirdPix & BOP: Emeritus Prof. Les Underhill (ADU, UCT)
DungBeetleMAP & LacewingMAP: Dr Mervyn Mansel (UP)
EchinoMAP: Emeritus Prof. Charles Griffiths (Biological Sciences, UCT)
FrogMAP and ReptileMAP: Dr Darren Pietersen (Tikki Hywood Foundation)
LepiMAP: Steve Woodhall (Lepidoptera Society)
MushroomMAP: Dr Marieka Gryzenhout (University of the Free State)
OdonataMAP: Dr Megan Lotftie-Eaton (ADU, UCT)
OrchidMAP: Prof. Craig Peter (Rhodes University)
PHOWN: Dr Dieter Oschadleus (BDI)
ScorpionMAP and SpiderMAP: Dr Ian Engelbrecht (SANBI)
MammalMAP and TreeMAP: no coordinator

Scientific publications 2019

Bold authors: Fitz CoE staff and Research Associates
Bold and underlined authors: Fitz CoE post-docs and students (current and graduated)

IF = Thomson Scientific Impact Factor score (2017, 2-year impact factor)

Aizen, M.A., Aguiar, S., Biesmeijer, J.C., Garibaldi, L.A., Inouye, D.W., Jung, C., Martins, D.J., Medel, R., Morales, C.L., Ngo, H., Pauw, A., Paxton, R.J., Sáez, A. and **Seymour, C.L.** 2019. Global agricultural productivity is threatened by increasing pollinator dependence without a parallel increase in crop diversification. *Global Change Biology* 25: 3516–3527. **IF: 8.880**

Amar, A., **Reynolds, C.**, **Van Velden, J.** and Briggs, C.W. 2019. Clinal variation in morph frequency in Swainson's hawk across North America: no support for Gloger's ecogeographical rule. *Biological Journal of the Linnean Society* 127: 299–309. **IF: 2.203**

Atkins, A., **Little, R.M.**, Redpath, S.M. and **Amar, A.** 2019. Impact of increased predation risk on vigilance behaviour in a gregarious waterfowl, the Egyptian goose *Alopochen aegyptiaca*. *Journal of Avian Biology* 50: e02121. **IF: 2.232**

Bester, M.N. and **Ryan, P.G.** 2019. Early pupping of a sub-Antarctic fur seal at Inaccessible Island, Tristan da Cunha. *Polar Biology*: 42:1221–1224. **IF: 2.002**

Bester, M.N. and **Ryan, P.G.** 2019. Stalked barnacles on an adult male sub-Antarctic fur seal at Inaccessible Island, Tristan da Cunha. *Polar Biology* 42:1943–1946. **IF: 2.002**

Bourne, A.R., **McKechnie, A.E.**, **Cunningham, S.J.**, **Ridley, A.R.**, Woodborne, S.M. and Karasov, W.H. 2019. Non-invasive measurement of metabolic rates in wild, free-living birds using doubly labelled water. *Functional Ecology* 33: 162-174. **IF: 5.037**

Campbell, K., **Steinfurth, A.**, Underhill, L., Coetzee, J., Dyer, B., Ludynia, K., **Makhado, A.**, Merkle, D., Rademan, J., Upfold, L. and Sherley, R., 2019. Local forage fish abundance influences foraging effort and offspring condition in an endangered marine predator. *Journal of Applied Ecology*. 56:1751–1760 **IF: 5.782**

Caravaggi, A., Cuthbert, R.J., **Ryan, P.G.**, Cooper, J. and Bond, A.L., 2019. The impacts of introduced House Mice on the breeding success of nesting seabirds on Gough Island. *Ibis* 161: 648-661. **IF: 1.994**

Carstens, K.F., Kassanjee, R., **Little, R.M.**, **Ryan, P.G.** and **Hockey, P.A.R.** 2019. Breeding success and population growth of Southern Ground Hornbills *Bucorvus leadbeateri* in an area supplemented with nest-boxes. *Bird Conservation International* 29: 627-643. **IF: 1.725**

Carstens, K.F., Kassanjee, R., **Little, R.M.**, **Ryan, P.G.** and **Hockey, P.A.R.** 2019. The effects of weather, group size and type of nest on the timing of egg-laying in the Southern Ground-hornbill *Bucorvus leadbeateri. Journal of Ornithology* 160: 633-640. **IF: 1.954**

Carstens, K.F., Kassanjee, R., **Little, R.M.**, **Ryan, P.G.**, and **Hockey, P.A.R.** 2019. Natal dispersal in the Southern Ground Hornbill *Bucorvus leadbeateri. Ostrich* 90: 119-127. **IF: 0.443**

Cerda-Cuéllar, M., Moré, E., Ayats, T., Aguilera, M., Muñoz-González, S., Antilles, N., **Ryan, P.G.** and González-Solís, J. 2019. Do humans spread zoonotic enteric bacteria in Antarctica? *Science of the Total Environment* 654: 190-196. **IF: 5.589**

Chaisi, M.E., **Osinubi, S.T.**, Dalton, D.L. and Suleman, E., 2019. Occurrence and diversity of avian haemosporidia in Afrotropical landbirds. *International Journal for Parasitology: Parasites and Wildlife* 8: 36-44. **IF: 2.075**

Chamberlain, D.E., Henry, D.A., **Reynolds, C.**, Caprio, E. and **Amar, A.** 2019. The relationship between wealth and biodiversity: A test of the Luxury Effect on bird species richness in the developing world. *Global Change Biology* 25: 3045–3055. **IF: 8.880**

Clairbaux, M., Fort, J., Mathewson, P., Porter, W., Strøm, H. and **Grémillet, D.** 2019. Climate change could overturn bird migration: transarctic flights and high-latitude residency in a sea ice free Arctic. *Scientific Reports* 9: 17767. **IF: 4.011**

Cole, T.L., Ksepka, D.T., Mitchell, K.J., Tennyson, A.J., Thomas, D.B., Pan, H., Zhang, G., Rawlence, N.J., Wood, J.R., Bover, P., Bouzat, J.L., Cooper, A., Fiddaman, R., Hart, T., Miller, G., **Ryan, P.G.**, Shepherd, L.D., Wilmshurst, J.M. and Waters, J.M. 2019. Mitogenomes uncover extinct penguin taxa and reveal island formation as a key driver of speciation. *Molecular Biology and Evolution* 36: 784–797. **IF: 14.797**

Connan, M., **Dilley, B.J.**, **Whitehead, T.O.**, **Davies, D.**, McQuaid, C.D. and **Ryan, P.G.** 2019. Multidimensional stable isotope analysis

illuminates resource partitioning in a sub-Antarctic island bird community. *Ecography* 42: 1948–1959. **IF: 5.946**

Conradie, S.R, Woodborne, S.M., **Cunningham, S.J.** and **McKechnie, A.E.** 2019. Chronic, sublethal effects of high temperatures will cause severe declines in southern African arid-zone birds during the 21st century. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 116: 14065–14070. **IF: 9.580**

Crawford, R. J. M., Sydeman, W. J., Thompson, S. A., Sherley, R. B. and **Makhado, A. B.** 2019. Food habits of an endangered seabird indicate recent poor forage fish availability off western South Africa. *ICES Journal of Marine Science* 76: 1344–1352. **IF: 3.367**

Crowe, T.M., **Little, R.M.** and Turner, D.A. 2019. Clarifying taxonomic, distributional and genetic information relating to subspecies of the Hildebrandt's Spurfowl *Pternistis hildebrandti* and the Yellow-necked Spurfowl *P. leucoscepus*. *Ostrich* 90: 279–280. **IF: 0.443**

de Kock, C. and **Lee, A.T.K.** 2019. Agulhas long-billed lark (*Certhilauda brevirostris*) densities, population estimates and habitat association in a transformed landscape. *African Zoology* 54: 161–168. **IF: 0.962**

Dilley, B.J., **Davies, D.**, **Stevens, K.**, **Schoombie, S.**, Schoombie, J. and **Ryan, P.G.** 2019. Burrow wars and sinister behaviour among burrow-nesting petrels at sub-Antarctic Marion Island. *Ardea* 107: 97-102. **IF: 1.125**

Dilley, B.J., Hedding, D.W., Henry, D.A., Rexer-Huber, K., Parker, G.C., **Schoombie, S.**, **Osborne, A.** and **Ryan, P.G.**, 2019. Clustered or dispersed: testing the effect of sampling strategy to census burrow-nesting petrels with varied distributions at sub-Antarctic Marion Island. *Antarctic Science* 31: 231-242. **IF: 1.653**

Dilley, B.J., **Davies, D.**, Mitham, A., Glass, T., Repetto, J., Swain, G. and **Ryan, P.G.** 2019. Population estimates of burrow-nesting petrels breeding at the Nightingale Island group, Tristan da Cunha Archipelago. *Marine Ornithology* 47: 267-275. **IF: 0.537**

Jeal, C., **Perold, V.**, **Seymour, C.L.**, Ralston-Paton, S. and **Ryan, P.G.** 2019. Utility-scale solar energy facilities – Effects on invertebrates in an arid environment. *Journal of Arid Environments* 168: 1-8. **IF: 1.825**

Jeal, C., **Perold, V.**, Ralston-Paton, S. and **Ryan, P.G.** 2019. Impacts of a concentrated solar power trough facility on birds and other wildlife in South Africa. *Ostrich* 90: 129-137. **IF: 0.443**

Jepsen, E.M., Ganswindt, A., Ngcamphalala, C.A., **Bourne, A.R.**, **Ridley, A.R.** and **McKechnie, A.E**. Non-invasive monitoring of physiological stress in an afrotropical arid-zone passerine bird, the southern pied babbler. *General and Comparative Endocrinology* 276: 60-68. **IF: 2.445**

Jones, C.W., **Risi, M.M.**, Cleeland, J. and **Ryan, P.G.** 2019. First evidence of mouse attacks on adult albatrosses and petrels breeding on sub-Antarctic Marion and Gough Islands. *Polar Biology* 42: 619-623. **IF: 2.002**

Kappes, P.J., Bond, A.L., Russell, J.C. and **Wanless, R.M.** 2019. Diagnosing and responding to causes of failure to eradicate invasive rodents. *Biological Invasions* 21: 2247–2254. **IF: 2.897**

Kemp, R. and **McKechnie, A.E.**, 2019. Thermal physiology of a range-restricted desert lark. *Journal of Comparative Physiology B* 189(1): 131-141. **IF: 2.341**

Le Bot, T., Lescroël, A., Fort, J., Péron, C., Gimenez, O., Provost, P. and **Grémillet, D.**, 2019. Fishery discards do not compensate natural prey shortage in Northern gannets from the English Channel. *Biological Conservation* 236: 375-384. **IF: 4.451**

Lee, A.T., Reeves, B. and Wright, D.R. 2019. Hottentot Buttonquail *Turnix hottentottus*: Endangered or just overlooked?. *Bird Conservation International* 29: 136-143. **IF: 1.725**

Little, R.M. and **Navarro, R.A.** 2019. Implications of geographical range changes and resultant sympatry for three *Accipiter* hawks on the Cape Peninsula, South Africa. *Ostrich* 90: 139-142. **IF: 0.443**

Loiseau, C., **Melo, M.**, Lee, Y., Pereira, H., Hanemaaijer, M.J., Lanzaro, G.C. and Cornel, A.J. 2019. High endemism of mosquitoes on São Tomé and Príncipe Islands: evaluating the general dynamic model in a worldwide island comparison. *Insect Conservation and Diversity* 12: 69-79. **IF: 2.313**

McEvoy, O.K., **Miller, S.M.**, Beets, W., Bodasing, T., Borrego, N., Burger, A., Courtenay, B., Ferreira, S., Hanekom, C., Hofmeyr, M., Packer, C., Robertson, D., Stratford, K., Slotow, R. and Parker, D.M. 2019. The use of contraceptive techniques in managed wild African lion (*Panthera leo*) populations to mimic open system cub recruitment. *Wildlife Research* 46 398-408 **IF: 1.244**

McInnes, A.M., **Ryan, P.G.**, Lacerda, M. and **Pichegru, L.** 2019. Targeted prey fields determine foraging effort thresholds of a marine diver: important cues for the sustainable management of fisheries. *Journal of Applied Ecology* 56: 2206–2215 **IF: 5.782.**

Mandiwana-Neudani, T.G., **Little, R.M.**, **Crowe, T.M.** and **Bowie, R.C.K. 2019.** Taxonomy, phylogeny and biogeography of African spurfowls Galliformes, Phasianidae, Phasianinae, Coturnicini: *Pternistis* spp. *Ostrich* 90: 145-172. **IF: 0.443**

Mandiwana-Neudani, T.G., **Little, R.M.**, **Crowe, T.M.** & **Bowie, R.C.K.** 2019. Taxonomy, phylogeny and biogeography of 'true' francolins: Galliformes, Phasianidae, Phasianinae, Gallini; Francolinus, Ortygornis, Afrocolinus gen. nov., Peliperdix and Scleroptila spp. *Ostrich* 90: 191–221. **IF: 0.443**

Masello, J.F., Quillfeldt, P., Sandoval-Castellanos, E., Alderman, R., Calderón, L., Cherel, Y., Cole, T.L., Cuthbert, R.J., Marin, M., Massaro, M., Navarro, J., Phillips, R.A., **Ryan, P.G.**, Shepherd, L.D., Suazo, C.G., Weimerskirch, H. and Moodley, Y. 2019. Additive traits lead to feeding advantage and reproductive isolation, promoting homoploid hybrid speciation. *Molecular Biology and Evolution* 36:1671–1685 **IF: 14.797**

Mzumara, T.I., **Martin, R.O.**, Tripathi, H., Phiri, C. and **Amar, A.** 2019. Distribution of a habitat specialist: Mopane woodland structure determines occurrence of Near Threatened Lilian's Lovebird *Agapornis lilianae*. *Bird Conservation International* 29: 413-422. **IF: 1.725**

Nebel, C., Gamauf, A., Haring, E., Segelbacher, G., Vali, U., Villers, A. and Zachos, F.E. 2019. New insights into population structure of the European golden eagle (*Aquila chrysaetos*) revealed by microsatellite analysis. *Biological Journal of the Linnean Society* 128: 611–631. **IF: 2.203**

Nebel, C., Kadletz, K., Gamauf, A., Haring, E., Sackl, P., Tiefenbach, M., Winkler, H. and Zachos, F.E. 2019. Witnessing extinction: Population genetics of the last European Rollers (*Coracias garrulus*) in Austria and a first phylogeographic analysis of the species across its distribution range. *Journal of Zoological Systematics and Evolutionary Research* 57: 461-475. **IF: 2.268**

Oswald, K.N., Smit, B., **Lee, A.T.** and **Cunningham, S.J.**, 2019. Behaviour of an alpine range-restricted species is described by interactions between microsite use and temperature. *Animal Behaviour* 157: 177-187. **IF: 2.675**

Pastor-Prieto, M., Ramos, R., Zajková, Z., Reyes-González, J.M., Rivas, M.L., **Ryan, P.G.** and González-Solís, J. 2019. Spatial ecology, phenological variability and moulting patterns of the Endangered Atlantic petrel *Pterodroma incerta*. *Endangered Species Research*, 40: 189-206. **IF: 2.122**

Pekor, A., Miller, J.R., Flyman, M.V., Kasiki, S., Kesch, M.K., **Miller, S.M.**, Uiseb, K., Van der Merve, V. and Lindsey, P.A. 2019. Fencing Africa's protected areas: Costs, benefits, and management issues. *Biological Conservation* 229: 67-75. **IF: 4.451**

Potgieter, L.J., Gaertner, M., **O'Farrell, P.J.** and Richardson, D.M. 2019. Perceptions of impact: invasive alien plants in the urban environment. *Journal of Environmental Management* 229: 76-87. **IF: 4.865**

Reading, R.P., Bradley, J., Hancock, P., **Garbett, R.**, Selebatso, M. and Maude, G., 2019. Home-range size and movement patterns of Hooded Vultures *Necrosyrtes monachus* in southern Africa. *Ostrich* 90: 73-77. **IF: 0.443**

Reynolds, C. 2019. Waterbirds: Birds of a feather flock together. Editorial *Ostrich* 90: iii-iv. **IF: 0.443**

Rink, A.N., Altwegg, R., Edwards, S., **Bowie, R.C.** and Colville, J.F. 2019. Contest dynamics and assessment strategies in combatant monkey beetles (Scarabaeidae: Hopliini). *Behavioral Ecology* 33: 713-723. **IF: 2.695**

Risi, M.M., **Jones, C.W.**, **Schoombie, S.** and **Ryan, P.G.** 2019. Plumage and bill abnormalities in albatross chicks on Marion Island. *Polar Biology* 42: 1615–1620. **IF: 2.002**

Robert, A., Lengagne, T., **Melo, M.**, Gardette, V., Julien, S., **Covas, R.**, Gomez, D. and **Doutrelant, C.** 2019. The theory of island biogeography and soundscapes: Species diversity and the organization of acoustic communities. *Journal of Biogeography* 46: 1901-1911. **IF: 3.884**

Roscales, J.L., Vicente, A., **Ryan, P.G.**, González-Solís, J. and Jiménez, B. 2019. Spatial and interspecies heterogeneity in concentrations of perfluoroalkyl substances (PFASs) in seabirds of the Southern Ocean. *Environmental Science & Technology* 53: 9855–9865. **IF: 7.149**

Ryan, P.G. and **Dilley, B.J.**, 2019. Intertidal foraging by Tristan Thrushes. *Ostrich* 90: 179–181. **IF: 0.443**

Ryan, P.G., Dilley, B.J., Davies, D., Glass, T. and Abadi, F. 2019. Short-term movement patterns, population estimates and breeding biology of an island endemic bird, the Tristan Thrush. *Revista Brasileira de Ornitologia* 27: 245-252**. IF 0.299**

Ryan, P.G., **Dilley, B.J.**, Ronconib, R.A. and Connan, M. 2019. Rapid increase in Asian bottles in the South Atlantic Ocean indicates major debris inputs from ships. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 116: 20892–20897 **IF: 9.580**

Sherley, R.B., Crawford, R.J.M., Dyer, B.M., Kemper, J., Makhado, A.B., Masoltla, M., **Pichegru, L., Pistorius, P.A.**, Roux, J-P., **Ryan, P.G.**, Tom, D., Upfold, L. and Winker, H. 2019. Identification of land predators of African Penguins *Spheniscus demersus* through post-mortem examination. *Ostrich* 90: 359-372. **IF: 0.443**

Sorensen, M.C., Dixit, T., Kardynal, K.J., Newton, J., Hobson, K.A., Bensch, S., Jenni-Eiermann, S. and **Spottiswoode, C.N.** 2019. Migration distance does not predict blood parasitism in a migratory songbird. *Ecology and Evolution* 9: 8294-8304. **IF: 2.415**

Steinfurth, A., Booth, J.M., White, J., Bond, A.L. and McQuaid, C.D. 2019. Sexual and geographic dimorphism in northern rockhopper penguins breeding in the South Atlantic Ocean. *Endangered Species Research* 39: 293-302. **IF: 2.122**

Szymkowiak, J. and **Thomson, R.L.** 2019. Nest predator avoidance during habitat selection of a songbird varies with mast peaks and troughs. *Behavioral Ecology and Sociobiology* 73: 91. **IF: 2.103**

Tucker, M.A., Alexandrou, O., Bierregaard Jr, R.O., Bildstein, K.L., Böhning-Gaese, K., Bracis, C., Brzorad, J.N., Buechley, E.R., Cabot, D., Calabrese, J.M., Carrapato, C., Chiaradia, A., Davenport, L.C., Davidson, S.C., Desholm, M., DeSorbo, C.R., Domenech, R., Enggist, P., Fagan, W.F., Farwig, N., Fiedler, W., Fleming, C.H., Franke, A., Fryxell, J.M., Garcia-Ripolles, C., **Grémillet, D.**, Griffin, L.R., Harel, R., Kane, A., Kays, R., Kleyheeg, E., Lacy, A.E., LaPoint, S., Liminana, R., Lopez-Lopez, P., Maccarone, A.D., Mellone, U., Mojica, E.K., Nathan, R., Newman, S.H., Noonan, M.J., Oppel, S., Prostor, M., Rees, E.C., Ropert-Coudert, Y., Rosner, S., Sapir, N., Schabo, D., Schmidt, M., Schulz, H., Shariati, M., Shreading, A., Silva, J.P., Skov, H., Spiegel, O., Takekawa, J.Y., Teitelbaum, C.S., van Toor, M.L., Urios, V., Vidal-Mateo, J., Wang, Q., Watts, B.D., Wikelski, M., Wolter, K., Zydelis, R. and Mueller, T. 2019. Large birds travel farther in homogeneous environments. *Global Ecology and Biogeography* 28: 576-587. **IF: 5.667**

van de Ven, T.M.F.N., McKechnie, A.E. and **Cunningham, S.J.** 2019. The costs of keeping cool: behavioural trade-offs between foraging and

thermoregulation are associated with significant mass losses in an arid-zone bird. *Oecologia* 191: 205–215. **IF: 2.915**

van Dyk, M., Noakes, M.J. and **McKechnie, A.E.** 2019. Interactions between humidity and evaporative heat dissipation in a passerine bird. *Journal of Comparative Physiology B* 189: 299-308. **IF: 2.431**

Vanstreels, R.E.T., Parsons, N.J., Mcgeoge, C., Hurtado, R., Ludynia, K., Waller, L., Ruthenberg, M., Purves, A., **Pichegru, L.** and **Pistorius**, P.A. 2019. The status and conservation of the Cape Gannet *Morus capensis*. *Ostrich* 90: 335-346. **IF: 0.443**

Visser, E., Perold, V., Ralston-Paton, S., Cardenal, A.C. and **Ryan, P.G.** 2019. Assessing the impacts of a utility-scale photovoltaic solar energy facility in birds in the Northern Cape, South Africa. *Renewable Energy* 133: 1285-1294. **IF: 5.439**

Wheeler, H.C., Berteaux, D., Furgal, C., Cazelles, K., Yoccoz, N.G. and **Grémillet, D**., 2019. Identifying key needs for the integration of social–ecological outcomes in arctic wildlife monitoring. *Conservation Biology* 33: 861-872. **IF: 6.194**

Willcock, S., Hooftman, D.A., Balbi, S., Blanchard, R., Dawson, T.P., **O'Farrell, P.J.**, Hickler, T., Hudson, M.D., Lindeskog, M., Martinez-Lopez, J., Mulligan, M., Reyers, B., Shackleton, C., Sitas, N., Villa, F., Watts, S.M., Eigenbrod, F., and Bullock, J.M. 2019. A continental-scale validation of ecosystem service models. *Ecosystems* 22: 1902–1917. **IF: 4.555**

Online Published Papers (76)

Abbas, H.A., Bond, W.J. and Midgley, J.J. 2019. The worst drought in 50 years in a South African savannah: Limited impact on vegetation. *African Journal of Ecology*. **IF: 0.893**

Abdulwahab, U.A., **Osinubi, S.T.** and Abalaka, J. 2019. Risk of predation: a critical force driving habitat quality perception and foraging behavior of granivorous birds in a Nigerian forest reserve. *Avian Research* 10. **IF: 0.818**

Afan I., Navarro J., **Grémillet D.**, Coll M. and Forero M.G. 2019. Maiden voyage into death: are fisheries affecting seabird juvenile survival during the first days at sea? *Royal Society Open Science* 6: 181151. **IF: 2.515**

Amélineau, F., **Grémillet, D.,** Harding, A.M., Walkusz, W., Choquet, R. and Fort, J. 2019. Arctic climate change and pollution impact little auk foraging and fitness across a decade. *Scientific reports* 9(1): 1014. **IF: 4.011**

Austin, R.E., Wynn, R.B., Votier, S.C., Trueman, C., McMinn, M., Rodríguez, A., Suberg, L., Maurice, L., Newton, J., Genovart, M., Péron, C., **Grémillet, D.**, and Guilford, T 2019. Patterns of at-sea behaviour at a hybrid zone between two threatened seabirds. *Scientific Reports* 9: 14720. **IF: 4.011**

Balbi, S., Selomane, O., Sitas, N., Blanchard, R., Kotzee, I., **O'Farrell, P.** and Villa, F. 2019. Human dependence on natural resources in rapidly urbanising South African regions. *Environmental Research Letters* 14: 044008. **IF: 6.192**

Bengtsson, J., Bullock, J.M., Egoh, B., Everson, C., Everson, T., O'Connor, T., **O'Farrell, P.J.**, Smith, H.G. and Lindborg, R. 2019. Grasslands - more important for ecosystem services than you might think. *Ecosphere* 10. **IF: 2.746**

Benoit, L., Hewison, A.M., Coulon, A., Debeffe, L., **Grémillet, D.**, Ducros, D., Cargnelutti, B., Chaval, Y. and Morellet, N., 2019. Accelerating across the landscape: The energetic costs of natal dispersal in a large herbivore. *Journal of Animal Ecology*. **IF: 4.364**

Bolopo, D., Lowney, A.M. and Thomson, R.L. 2019. Helpers improve fledgling body condition in bigger broods of cooperatively breeding African pygmy falcon. *Behavioral Ecology and Sociobiology* 73: 16. **IF: 2.103**

Brown, J.I., Lavretsky, P., **Cumming, G.S.** and Peters, J.L. 2019. Strong population structure and limited gene flow between Yellow-billed Ducks and Mallards in southern Africa. *Condor*. **IF: 2.804**

Dean, W.R.J. and Milton, S.J. 2019. The dispersal and spread of invasive alien *Myrtillocactus geometrizans* in the southern Karoo, South Africa. *South African Journal of Botany* 121: 210-215. **IF: 1.504**

Ezenwa, I.M., Nwani, C., Ottosson, U. and **Martin, R.O**., 2019. Opportunities to boost protection of the grey parrot in Nigeria. *Oryx* 53: 212-213. **IF: 2.801**

Garcia-Heras, M-S., Arroyo, B., Mougeot, F., Bildstein, K., Therrien, J-F. and **Simmons, R.E.** 2019. Migratory patterns and settlement areas revealed by remote sensing in an endangered intra-African migrant, the Black Harrier (*Circus maurus*). *PLoS ONE* 14(1): e0210756. **IF: 2.776**

Gerson, A.R., **McKechnie, A.E.**, Smit, B., **Whitfield, M.C.**, Smith, E.K., Talbot, W.A., McWhorter, T.J. and Wolf, B.O. 2019. The functional significance of facultative hyperthermia varies with body size and phylogeny in birds. *Functional Ecology.* **IF: 5.037**

Gittins, O., Grau-Roma, L., Valle, R., Abad, F.X., Nofrarías, M., **Ryan, P.G.,** González-Solís, J. and Majó, N. 2019. Serological and molecular surveys of influenza A viruses in Antarctic and sub-Antarctic wild birds. *Antarctic Science*. **IF: 1.653**

Grecian, J., Williams, H., Votier, S., Bearhop, S., Cleasby, I., **Grémillet, D.**, Hamer, K., Le Nuz, M., Lescroël, A., Newton, J., Patrick, S., Phillips, R.A., Wakefield, E.D. and Bodey, T.W. 2019. Individual spatial consistency and dietary flexibility in the migratory behaviour of northern gannets wintering in the Northeast Atlantic. *Frontiers in Ecology and Evolution* 7: 214. **IF: 2.686**

Grémillet, D., Collet, J., Weimerskirch, H., Courbin, N., **Ryan, P.G.** and Pichegru, L. 2019. Radar detectors carried by Cape gannets reveal surprisingly few fishing vessel encounters. *PLoS ONE* 14(2): e0210328. **IF: 2.776**

Gush, W.G., Maphisa, D.H., **Reynolds, C.**, Donald, P.F. and **Spottiswoode, C.N.** 2019. Declines of the globally threatened Rudd's Lark *Heteromirafra ruddi* in one of its last remaining strongholds. *Bird Conservation International*. **IF: 1.725**

Holmes, N.D., Spatz, D.R., Oppel, S., Tershy, B., Croll, D.A., Keitt, B., Genovesi, P., Burfield, I.J., Will, D.J., Bond, A.L. and Wegmann, A., Aguirre-Munoz, A., Raine, A.F., Knapp, C.R., Hung, C-H., Wingate, D., Hagen, E., Mendez-Sanchez, F., Rocamora, G., Yuan, H-W., Fric, J., Millet, J., Russell, J., Liske-Clark, J., Vidal, E., Jourdan, H., Campbell, K., Springer, K., Swinnerton, K., Gibbons-Decherong, L., Langrand, O., Brooke, M de L., McMinn, M., Bunbury, N., Oliveira, N., Sposimo, P., Geraldes, P., McClelland, P., Hodum, P., **Ryan, P.G.**, Borroto-Paez, R., Pierce, R., Griffiths, R., Fisher, R.N., **Wanless, R.**, Pasachnik, S.A., Cranwell, S., Micol, T. and Butchart, S.H.M. 2019. Globally important islands where eradicating invasive mammals will benefit highly threatened vertebrates. PloS ONE 14(3): e0212128. **IF: 2.776**

Jansen, D.Y., Pradel, R., Mares, R., Doutrelant, C., **Spottiswoode, C.N.**, **Covas, R.** and Altwegg, R. 2019. An integrated population model sheds light on the complex population dynamics of a unique colonial breeder. *Population Ecology*. **IF: 1.512**

Jansen, D.Y., Lloyd, P., Oschadleus, H.D. and Altwegg, R. 2019. Survival synchronicity in two avian insectivore communities. *Ibis*. **IF: 1.994**

Jenkins, A.R., **Van Zyl, A.J.**, Magunje, I., Matsvimbo, F., **Rodrigues, L.**, Robinson, L., Sebele, L., Tiran, D. and Smit-Robinson, H. 2019. Status of the Taita Falcon (*Falco fasciinucha*) and Other Cliff-Nesting Raptors in Batoka Gorge, Zimbabwe. *Journal of Raptor Research* 53: 46-55. **IF: 1.167**

Jones, C.W., **Risi, M.M.** and Cooper, J. 2019 An incubating northern giant petrel actively feeds on a Salvin's prion. *Antarctic Science*. **IF: 1.653**

Jones, M.G.W., Techow, N.M.S., **Risi, M.M.**, **Jones, C.W.**, Hagens, Q.A., Taylor, F. and **Ryan, P.G.** 2019**.** Hybridization and cuckoldry between black-browed and grey-headed albatrosses. *Antarctic Science*. **IF: 1.653**

Joseph, G.S., Muluvhahothe, M.M., **Seymour, C.L.**, Munyai, T.C., Bishop, T.R. and Foord, S.H. 2019. Stability of Afromontane ant diversity decreases across an elevation gradient. *Global Ecology and Conservation* e00596. **IF: 2.751**

Lee, A.T.K. 2019. Best student research paper published in *Ostrich* 2018. *Ostrich* 90: iii-v. DOI: **IF: 0.443**

Lee, A.T.K., Geary, C., Wright, D.R. and **Dean, W.R.J.** 2019. Vulnerability of birds to contaminated water sources in the Karoo region of South Africa. *Ostrich* 90:4. **IF: 0.443**

Le Guen, C., Suaria, G., **Sherley, R.B.**, **Ryan, P.G.**, Aliani, S., Boehme, L., Brierley, A.S. 2019. Microplastic study reveals the presence of natural and synthetic fibres in the diet of King Penguins (*Aptenodytes patagonicus*) foraging from South Georgia. *Environment International* 134: 105303. **IF: 7.943**

Lescroël, A., Ballard, G., Massaro, M., Dugger, K., Jennings, S., Pollard, A., Porzig, E., Schmidt, A., Varsani, A., **Grémillet, D.** and Ainley, D. 2019. Evidence of age-related improvement in the foraging efficiency of Adélie penguins. *Scientific Reports* 9(1): 3375. **IF: 4.011**

Lombard, A.T., Dorrington, R.A., Ortega-Cisneros, K., Penry, G.S., **Pichegru, L.**, Reed, J.R., Smit, K.P., Vermeulen, E.A., Witteveen, M., Sink, K.J. and Ginsburg, T. 2019. Key challenges in advancing an ecosystem-based approach to marine spatial planning under economic growth imperatives. *Frontiers in Marine Science* 6: 146. **IF: 3.086**

McClelland, S.C., **Jamie, G.A.**, Waters, K., Caldas, L., **Spottiswoode, C.N.** and Portugal, S.J. 2019. Convergent evolution of reduced eggshell

conductance in avian brood parasites. *Philosophical Transactions of the Royal Society B* 374: 20180194. **IF: 6.139**

Martin, R.O., Senni, C., D'cruze, N. and Bruschi, N. 2019. Tricks of the trade—legal trade used to conceal Endangered African grey parrots on commercial flights. *Oryx* 53: 213-213. **IF: 2.801**

Mays, H.L., Oehler, D.A., Morrison, K.W., Morales, A.E., Lycans, A., Perdue, J., Battley, P.F., Cherel, Y., Chilvers, B.L., Crofts, S., Demongin, L., Fry, W.R., Hiscock, J., Kusch, A., Marin, M., Poisbleau, M., Quillfeldt, P., Rey, A.R., **Steinfurth, A.**, Thompson, D.R. and Weakley, L.A. 2019. Phylogeography, Population Structure, and Species Delimitation in Rockhopper Penguins (*Eudyptes chrysocome and Eudyptes moseleyi*). *Journal of Heredity*. **IF: 2.618**

Merkel, B., Descamps, S., Yoccoz, N.G., Danielsen, J., Daunt, F., Erikstad, K.E., Ezhov, A.V., **Grémillet, D.**, Gavrilo, M., Lorentsen, S.H., Reiertsen, T.K., Steen, H., Systad, G.H., Þórarinsson, Þorkell Lindberg, Wanless, S. and Strøm, H. 2019. Earlier colony arrival but no trend in hatching timing in two congeneric seabirds (*Uria* spp.) across the North Atlantic. *Biology Letters* 15(10):20190634. **IF: 3.323**

Miller, S.M., Druce, D.J., Dalton, D.L., Harper, C.K., Kotze, A., Packer, C., Slotow, R. and Bloomer, P., 2019. Genetic rescue of an isolated African lion population. *Conservation Genetics*. **IF: 2.283**

Morosinotto, C., **Thomson, R.L.**, Korpimäki, E., Mateo, R. and Ruuskanen, S. 2019. Maternal food supplementation and perceived predation risk modify egg composition and eggshell traits but not offspring condition. *Journal of Experimental Biology* 222 (19). **IF: 3.017**

Murgatroyd, M., **Redpath, S.M.**, Murphy, S.G., Douglas, D.J., Saunders, R. and **Amar, A.** 2019. Patterns of satellite tagged hen harrier disappearances suggest widespread illegal killing on British grouse moors. *Nature Communications*, 10(1) **IF: 11.878**

Mutumi, G.L., **Cumming, G.S.**, Sullivan, S.M.P., Caron, A. and Cáceres, C. 2019. Using a multi-isotope approach to understand waterfowl movement in southern Africa. *Condor*. **IF: 2.804**

Naude, V.N., Smyth, L.K., **Weideman, E.A.**, **Krochuk, B.A.** and **Amar, A.** 2019. Using web-sourced photography to explore the diet of a declining African raptor, the Martial Eagle (*Polemaetus bellicosus*). *Condor* 121:1-9. **IF: 2.804**

Navarro, J., **Grémillet, D.**, Afán, I., Miranda, F., Bouten, W., Forero, M.G. and Figuerola, J., 2019. Pathogen transmission risk by opportunistic gulls moving across human landscapes. *Scientific Reports*, 9(1): 10659. **IF: 4.011**

Nebel, C., Harl, J., Pajot, A., Weissenböck, H., **Amar, A.** and **Sumasgutner, P.** 2019. High prevalence and genetic diversity of *Haemoproteus columbae* (Haemosporida: Haemoproteidae) in feral pigeons *Columba livia* in Cape Town, South Africa. *Parasitology Research*. **IF: 2.067**

Nebel, C., **Sumasgutner, P.**, Pajot, A. and **Amar, A.** 2019. Response time of an avian prey to a simulated hawk attack is slower in darker conditions, but is independent of hawk colour morph. *Royal Society Open Science* 6(8): 190677. **IF: 2.515**

Pakanen, V.M., Blomqvist, D., Breiehagen, T., Flodin, L.Å., Hildén, O., Lank, D.B., Larsson, M., Lislevand, T., Nuotio, K., Olsson, P., Ottvall, R., Pauliny, A., Pehlak, H., Ronka, A., Ronka, N., Schamel, D., Soikkeli, M., **Thomson, R.L.,** Thorup, O., Tomkovich, P., Tracy, D., Koivula, K. 2019. Low Frequencies of Supernormal Clutches in the Southern Dunlin and the Temminck's Stint. *Ardea* 107: 61-74. **IF: 1.125**

Paijmans, D.M., **Rose, S.** and Oschadleus, H.D. 2019. Using large-scale citizen science ringing data as a means of calculating maximum longevity in birds. *Bothalia* 49. **IF: 1.340**

Pan, H., Cole, T.L., Bi, X., Fang, M., Zhou, C., Yang, Z., Ksepka, D.T., Hart, T., Bouzat, J.L., Argilla, L.S., Bertelsen, M.F., Boersma, P.D., Bost, C.A., Cherel, Y., Dann, P., Fiddaman, S.R., Howard, P., Labuschagne, K., Mattern, T., Miller, G., Parker, P., Phillips, R.A., Quillfeldt, P., **Ryan, P.G.**, Taylor, H., Thompson, D.R., Young, M.J., Ellegaard, M.R., Gilbert, M.T.P., Sinding,

M.H.S., Pacheco, G., Shepherd, L.D., Tennyson, A.J.D., Grosser, S., Kay, E., **Nupen, L.J.**, Ellenberg, U., Houston, D.M., Reeve, A.H., Johnson, K., Masello, J.F., Stracke, T., McKinlay, B., García Borboroglu, P., Zhang, D.X. and Zhang, G. 2019. High-coverage genomes to elucidate the evolution of penguins. *GigaScience* 8. **IF: 4.688**

Reynolds, S.J., Ibáñez-Álamo, J.D., **Sumasgutner, P.** and Mainwaring, M.C., 2019. Urbanisation and nest building in birds: a review of threats and opportunities. *Journal of Ornithology.* **IF: 1.954**

Rexer-Huber, K., Veale, A.J., Catry, P., Cherel, Y., Dutoit, L., Foster, Y., McEwan, J.C., Parker, G.C., Phillips, R.A., **Ryan, P.G.** and Stanworth, A.J., van Stijn, T., Thomson, D.R., Waters, J. and Robertson, B.C. 2019. Genomics detects population structure within and between ocean basins in a circumpolar seabird: the white-chinned petrel. *Molecular Ecology* 28: 4552–4572. **IF: 5.855**

Ripple, W.J., Wolf, C., Newsome, T.M., **Barnard, P**., Moomaw, W.R. *et al.* 2019. World scientists' warning of a climate emergency. *BioScience*. **IF: 6.591**

Rodríguez, A., Arcos, J.M., Bretagnolle, V., Dias, M.P., Holmes, N.D., Louzao, M., Provencher, J., Raine, A.F., Ramírez, F., Rodríguez, B., Ronconi, R.A., Taylor, R.S., Bonnaud, E., Borrelle, S.B., Cortes, V., Descamps, S., Friesen, V.L., Genovart, M., Hedd, A., Hodum, P., Humphries, G.R.W., Le Corre, M., Lebarbenchon, C., Martin, R., Melvin, E.F., Montevecchi, W.A., Pinet, P., Pollet, I.L., Ramos, R., Russell, J.C., **Ryan, P.G.**, Sanz-Aquilar, A., Spatz, D.R., Travers, M., Votier, S.C., **Wanless, R.M.**, Woehler, E. and Chiaradia, A. 2019. Future directions in conservation research on Petrels and Shearwaters. *Frontiers in Marine Science* 6: 94. **IF: 3.086**

Ropert-Coudert, Y., Chiaradia, A., Ainley, D., Barbosa, A., Boersma, P.D., Brasso, R., Dewar, M., Ellenberg, U., García-Borboroglu, P., Emmerson, L., Hickcox, R., Jenouvrier, S., Kato, A., McIntosh, RR., Lewis, P., Ramírez, F., Ruoppolo, V., **Ryan, P.G.**, Seddon, P.J., Sherley, R.B., Vanstreels, R.E.T., Waller, L.J., Woehler, E.J. and Trathan, P.N. 2019. Happy feet in a hostile world? The future of penguins depends on proactive management of current and expected threats. *Frontiers in Marine Science* 6: 248. **IF: 3.086**

Rose, S., Oschadleus, H.D. and **Paijmans, D.**, 2019. How far and how old: Longevity and displacement records from the South African Bird Ringing Scheme for *Ardeidae, Threskiornithidae and Ciconiidae*. *Bothalia*, 49(1). **IF: 1.340**

Rose, S., **Thomson, R.L.**, Oschadleus, H.D. and **Lee, A.T.** 2019. Summarising biometrics from the SAFRING database for southern African birds. *Ostrich*. **IF: 0.443**

Ryan, P.G., Lee, J.R. and Le Bouard, F. 2019. Moult intensity in blue petrels and a key moult site off West Antarctica. *Antarctic Science* **IF: 1.653**

Ryan, P.G., **Dilley, B.J.** and Ronconi, R.A. 2019. Population trends of Spectacled Petrels Procellaria conspicillata and other seabirds at Inaccessible Island. *Marine Ornithology* 47: 257-265**. IF: 0.537**

San-Jose, L.M., Séchaud, R., Schalcher, K., Judes, C., Questiaux, A., Oliveira-Xavier, A., Gémard, C., Almasi, B., Béziers, P., Kelber, A. and **Amar, A.** 2019. Differential fitness effects of moonlight on plumage colour morphs in barn owls. *Nature Ecology & Evolution*. **IF: 10.965**

Schoombie, S., **Schoombie, J.**, **Brink, C.W.**, **Stevens, K.L.**, **Jones, C.W.**, **Risi, M.M.** and **Ryan, P.G.** 2019. Automated extraction of bank angles from bird-borne video footage using open-source software. *Journal of Field Ornithology*. **IF: 1.846**

Senfeld, T., Shannon, T.J., Van Grouw, H., **Paijmans, D.M.**, Tavares, E.S., Baker, A.J., Lees, A.C. and Collinson, J.M. 2019. Taxonomic status of the extinct Canary Islands Oystercatcher *Haematopus meadewaldoi*. *Ibis*. **IF: 1.994**

Seymour, C.L., **Milton, S.J.**, Altwegg, R., **Joseph, G.S.** and **Dean, W.R.J.** 2019. Addition of Nitrogen Increases Variability of Vegetation Cover in an Arid System with Unpredictable Rainfall. *Ecosystems*. **IF: 4.555**

Seymour, C.L., Gillson, L., Child, M.F., Tolley, K.A., Curie, J.C., da Silva, J.M., Alexander, G.J., Anderson, P., Downs, C.T., Egoh, B.N. and Smith, D.A.E., Ehlers Smith, Y.C., Esler, K.J., **O'Farrell, P.J.**, Skowno, A.L., Suleman, E. and Veldtman, R. 2019. Horizon scanning for South African biodiversity: a need for social engagement as well as science. *Ambio*. **IF: 4.103**

Smit, B., Woodborne, S., Wolf, B.O. and **McKechnie, A.E.** 2019. Differences in the use of surface water resources by desert birds are revealed using isotopic tracers. *The Auk* 136: 1-13. **IF: 2.659**

Spottiswoode, C.N. and Busch, R. 2019. Vive la difference! Self/non-self recognition and the evolution of signatures of identity in arms races with parasites. *Philosophical Transactions of the Royal Society B* 374: 20180206. **IF: 6.139**

Stephens, K., Measey, J., **Reynolds, C.** and Le Roux, J.J. 2019. Occurrence and extent of hybridisation between the invasive Mallard Duck and native Yellow-billed Duck in South Africa. *Biological Invasions*. **IF: 2.897**

Stoddard, M.C., Hogan, B.G., Stevens, M. and **Spottiswoode, C.N.** 2019. Higher-level pattern features provide additional information to birds when recognizing and rejecting parasitic eggs. *Philosophical Transactions of the Royal Society B* 374(1769): 20180197. **IF: 6.139**

Stofberg, M., **Cunningham, S.J.**, **Sumasgutner, P.** and **Amar, A.** 2019. Juggling a "junk-food" diet: responses of an urban bird to fluctuating anthropogenic-food availability. *Urban Ecosystems*. **IF: 2.493**

Sumasgutner, P., Terraube, J., Coulon, A., Villers, A., Chakarov, N., Kruckenhauser, L. and Korpimäki, E., 2019. Landscape homogenization due to agricultural intensification disrupts the relationship between reproductive success and main prey abundance in an avian predator. *Frontiers in Zoology* 16: 1-14. **IF: 2.982**

Sumasgutner, P., Koeslag, A. and **Amar, A.** 2019. Senescence in the city: exploring ageing patterns of a long-lived raptor across an urban gradient. *Journal of Avian Biology.* **IF: 2.232**

Thorogood, R., **Spottiswoode, C.N.**, Portugal, S.J. and Gloag, R., 2019. The coevolutionary biology of brood parasitism: a call for integration. *Philosophical Transactions of the Royal Society B*. 374: 20180190. **IF: 6.139**

Torney, C.J., **Lloyd-Jones, D.J.**, Chevallier, M., Moyer, D.C., Maliti, H.T., Mwita, M., Kohi, E.M. and Hopcraft, G.C. 2019. A comparison of deep learning and citizen science techniques for counting wildlife in aerial survey images. *Methods in Ecology and Evolution* **IF: 7.099**

Traisnel, G. and **Pichegru, L.** 2019. Boldness at the nest predicts foraging and diving behaviour of female but not male African penguins. *Animal Behaviour* 150: 113-125. **IF: 2.675**

Traisnel, G. and **Pichegru, L.**, 2019. Success comes with consistency in hard times: foraging repeatability relates to sex and breeding output in African penguins. *Marine Ecology Progress Series* 608: 279-289. **IF: 2.359**

Tripathi, H.G., **Mzumara, T.I.**, **Martin, R.O.**, Parr, C.L., Phiri, C. and Ryan, C.M. 2019. Dissimilar effects of human and elephant disturbance on woodland structure and functional bird diversity in the mopane woodlands of Zambia. *Landscape Ecology* 34: 357-371. **IF: 4.349**

van de Crommenacker, J., Bunbury, N., Jackson, H.A., **Nupen, L.J.**, **Wanless, R.**, Fleischer-Dogley, F., Groombridge, J.J. and Warren, B.H. 2019. Rapid loss of flight in the Aldabra white-throated rail. *PloS ONE*. **IF: 2.776**

Villar Couto, C.M., **Cumming. G.S.**, Lacorte, G.A., Congrains, C., Izbicki, R., Braga, E.M., Rocha, C.D., Moralez-Silva. E., **Henry, D.A.W**, Manu, S.A., Abalaka, J., Regalla, A., da Silva, A.S., Diop, M.S. and Del Lama, S.N. 2019. Avian haemosporidians in the cattle egret (*Bubulcus ibis*) from central-western and southern Africa: High diversity and prevalence. *PLoS ONE* 14 (2): e0212425. **IF: 2.776**

Weideman, E.A., Slingsby, J.A, **Thomson, R.L.** and Coetzee, B.T.W. 2019. Land cover change homogenizes functional and phylogenetic diversity within and among African savanna bird assemblages. *Landscape Ecology* **IF: 4.349**

Weideman, E.A., **Perold, V.** and **Ryan, P.G.**, 2019. Little evidence that dams in the Orange–Vaal River system trap floating microplastics or microfibres. *Marine Pollution Bulletin* 149: 110664 **IF: 3.782**

Papers in non-ranked journals (12)

Published hard-copy journals (9):

Adekola, O.E., Odewumi, O.S. and Agbelusi, E.A. 2019. Avian pests of cereal crops in rainforest and savanna agro-ecological zones, Ondo State, Nigeria. *Journal of Research in Forestry, Wildlife and Environment* 11(1): 11-23.

de Swardt, D.H., **Lee, A.**, Butler, H.J.B. and Oschadleus, H.D. 2019. Biometrics and diet of two closely related birds: Karoo Prinia (*Prinia maculosa*) and Drakensberg Prinia (*Prinia hypoxantha*). *Indago* 34(2): 125-133.

De Vos, A. and **Cumming, G.S.** 2019. The contribution of land tenure diversity to the spatial resilience of protected area networks. *People and Nature* 1: 331-346.

Flood, R.L. 2019. Bulwer's Petrels with whitish or pale underbody. *Dutch Birding* 41: 183–185.

Flood, R.L., and Gutiérrez, R. 2019. The status of Cory's Shearwater in the western Mediterranean Sea. *Dutch Birding* 41: 159–165.

Flood, R.L., de Lima, R.F., **Melo, M.**, Verbelen, P. and Wagstaff, W.H. 2019. What is known about the enigmatic Gulf of Guinea band-rumped storm petrels *Hydrobates* cf. *castro*? *Bulletin of the British Ornithologists' Club* 139: 173-186.

Flood, R.L. and van der Vliet, R., 2019. Variation and identification of Barolo Shearwater and Boyd's Shearwater. *Dutch Birding* 41: 215-237.

Mills, M.S., Boesman, P. and Collar, N.J., 2019. Species limits in the African Palm Swift Cypsiurus parvus. *Bulletin of the British Ornithologists' Club* 139(1): 75-82.

Wright, N., Fisher, A. & **Flood, R**. 2019. Eastern Orphean Warbler on the Isles of Scilly: new to Britain. *British Birds* 112: 146-152.

Online published papers (3):

Dean, W.R.J., **Seymour, C.L.**, **Joseph, G.S.** and Foord, S.H. 2019. A Review of the Impacts of Roads on Wildlife in Semi-Arid Regions. *Diversity* 11(5).

Pfaff, M.C., Logston, R.C., Raemaekers, S.J., Hermes, J.C., Blamey, L.K., Cawthra, H.C., Colenbrander, D.R., Crawford, R.J., Day, E., du Plessis, N. and Elwen, S.H., Fawcett, S.E., Jury, M.R., Karenyi, N., Kerwath, S.E., Kock, A.A., Krug, M., Lamberth, S.J., Omardien, A., Pitcher, G.C., Rautenbach, C., Robinson, T.B., Rouault, M., **Ryan, P.G.**, Shillington, F.A., Sowman, M., Sparks, C.C., Turpie, J.K., van Niekerk, L., Waldron, H.N., Yeld, E.M. and Kirkman, S.P. 2019. A synthesis of three decades of socio-ecological change in False Bay, South Africa: setting the scene for multidisciplinary research and management. *Elementa: Science of the Anthropocene* 7(32).

Preston, G.R., **Dilley, B.J.**, Cooper, J., Beaumont, J., Chauke, L.F., Chown, S.L., Devanunthan, N., Dopolo, M., Fikizolo, L., Heine, J., Henderson, S., Jacobs, C.A., Johnson, F., Kelly, J., Makhado, A.B., Marais, C., Maroga, J., Mayekiso, M., McClelland, G., Mphepya, J., Muir, D., Ngcaba, N., Ngcobo, N., Parkes, J.P., Paulsen, F., **Schoombie, S.**, Springer, K., Stringer, C., Valentine, H., **Wanless R.M.** and **Ryan, P.G.** 2019. South Africa works towards eradicating introduced house mice from sub-Antarctic Marion Island: the largest island yet attempted for mice. In: Veitch, C.R., Clout, M.N., Martin, A.R., Russell, J.C. and West, C.J. (eds). *Island invasives: scaling up to meet the challenge: Proceedings of the International Conference on island invasives 2017*: 40.

Popular publications 2019

Anon. 2019. Nesting on photovoltaic solar energy infrastructure. *NRF Science Matters* 2(2): 20-21.

Anon. 2019.Birds of a feather flock together? Not when the furnace is on. *NRF Science Matters* 2(2): 14-15.

Bourne, A.R. and Cunningham, S.J. 2019. No touching please! Non-invasive physiological measurements in wild animals. *Quest* 15(4): 32-33.

Bourne, A.R. and Pattinson, N. 2019. Hot birds in the top end. *Promerops* 315: 26-27.

Bourne, A.R., Cunningham, S.J., Nupen, L., McKechnie, A.E. and Ridley, A.R. 2019. Male and female southern pied babbler *Turdoides bicolor* nestlings respond similarly to heat stress. *British Ornithologists Union project report.*

Craig, C. 2019. Using technology to understand how Western Cape Blue Cranes move. *Promerops* 315: 11-12.

Coetzee, A. and Geerts, S. 2019. Patch works: connecting plants, birds and people. *African Birdlife* 7(5): 62-64.

Cunningham, S. The FitzPatrick Report: Hands off, the proof is in the poo. *African Birdlife* 7(4): 18.

Cunningham, S. 2019. In a dead heat. *Wild* Winter 47: 72-75.

Dixit, T., Walton, J. and Lund, J. 2019. Malachite Sunbird promiscuity? *Promerops* 315: 23.

Evans, C. 2019. The magic never dies. *Birdlife Africa* May/June: 59-62.

FIAO. 2019. The FitzPatrick Report: Stressed birds. *African Birdlife* 7(2): 18.

Flores, S. 2019. Friends of the fluffball. *Wild* Summer 2019/2020, 49: 80-84.

Howes, C: 2019. Knock-on effects: European Honey Buzzards on the rise. *African Birdlife* 7(2): 64.

Jamie, G.A., McClean, L., Moya, C. and Spottiswoode, C.N. 2019 The chick of the Locust Finch *Paludipasser locustella*. *Bulletin of the African Bird Club* 26: 198-201.

Little, R. 2019. Iconic Thunderbirds. *Kruger Magazine* Winter 8: 42-49.

Little, R. 2019. Chukars & Peafowls of Robben Island. *Promerops* July 314: 11.

Little, R. 2019. Birding the Stormberg. *Promerops* November 315: 10-11.

Little, R. 2019. Goslings walk the gauntlet. *Promerops* March 313: 23.

Little, R. 2019. Birding extravaganza in Uganda. *Safari News* Spring 2019: 23.

Little, R. 2019. Birding in our national parks. *Safari News* Winter 2019: 31.

Little, R. 2019. Geese have the final say. *Wingshooter* June/July 25(2): 16-18.

Little, R. 2019. Birding in South Africa's National Parks. *Wingshooter* September/October 25(3): 8.

Little, R. 2019. New Spurfowls & Francolins. *Wingshooter* September/October 25(3): 32-34.

Little, R. 2019. Uganda birding extravaganza. *Science Matters: Science Faculty Newsletter* 8(2): 14.

McKechnie, A. 2019. Separation anxiety: untangling the pipit family tree. *African Birdlife* 7(3): 12.

McKechnie, A. 2019. Above and beyond: Overachievers in the bird world. *African Birdlife* 8(1): 34-38.

McKechnie, A. and Cunningham, S. 2019. Facing the furnace: how heat affects behaviour in birds. *African Birdlife* 7(2): 23-27.

McKechnie, A. and Cunningham, S. 2019. 10 years of the Hot Birds Project. *African Birdlife* 8(1) 16-17.

Murgatroyd, M. and Amar, A. 2019. The FitzPatrick Report: Tag Team: Using satellite tags to understand wildlife crime. *African Birdlife* 7(6): 18.

Murgatroyd, M. 2019 Balancing energy needs and conservation. *Safari News* Autumn 2019: 19.

Naude, V. and Amar, A. 2019. How Google images helped us pin down the diet of Africa's largest eagle. *The Conversation*, Africa Edition. 15 April.

Nebel, C. 2019. A predation risk experiment: What makes prey an easy snack for predators? *Science Matters: Science Faculty Newsletter* 8(2): 12.

Oswald, K. 2019. Rocky road: Cape Rockjumper. *African Birdlife* 7(3): 50-54.

Ryan, P. 2019. Bottleneck: by the skin of their non-existent teeth. *African Birdlife* 7(6): 10.

Ryan P, 2019. The FitzPatrick Report: Annual reporting. *African Birdlife* 7(5): 16-17.

Ryan, P. 2019. Testing, testing: Too much knowledge can be a dangerous thing. *African Birdlife* 7(5): 20-21.

Ryan, P. 2019. Cotton on: The risk of entanglement to birds. *African Birdlife* 7(5): 38.

Ryan, P. 2019. Island survivor. *African Birdlife* 7(5). 50-55.

Ryan, P. 2019. Hands across the seas: Another Africa - New Zealand link. *African Birdlife* 7(4): 11.

Ryan, P. 2019. Travelling trogons. *African Birdlife* 7(3): 10.

Ryan, P. 2019. Dicing with death. *African Birdlife* 7(3): 11.

Ryan, P. 2019. The FitzPatrick Report: Measuring research impact. *African Birdlife* 7(3): 18.

Ryan, P. 2019. Review: Leica APO Televid 82 with 25-50x WW zoom eyepiece. *African Birdlife* 7(3): 56-57.

Ryan, P. 2019. Seabird saviours: tropical seabirds affect coral reefs. *African Birdlife* 7(2):10-11.

Ryan, P. 2019. Review of BirdLife South Africa's conservation work. *BirdLife South Africa Annual Report* 2018: 31.

Ryan, P. 2019. Plastic poses a major environmental threat: but is it being over-stated? *The Conversation*, Africa Edition. 11 July.

Ryan, P. and Lee, J. 2019. White-necked Raven feeding from Eland. *Promerops* 315: 24.

Ryan, P., Ludynia, K., Pichegru, L. 2019. Ships' risky fuel transfers are threatening African Penguins. *The Conversation* Africa Edition. 4 September.

SABAP. 2019. Refreshing the interface: Makeover for the SABAP2 website. *African Birdlife* 7(3): 62.

SABAP. 2019. SABAP2 gives back. *African Birdlife* 7(4): 56.

SABAP. 2019. Cities' limits. *African Birdlife* 7(6): 21.

SABAP. 2019. Agulhas Plain Birding Project. *African Birdlife* 8(1): 61.

Underhill, L. 2019. SABAP spreads its wings: The African Bird Atlas Project. *African Birdlife* 7(5): 61.

Chapters in Books (7)

Cumming, D. 2019. "Conserving elephants in the Anthropocene." *In*: Wilson, J.W. and Primack, R.B. *Conservation Biology in Sub-Saharan Africa*. Open Book Publishers. p 227.

Cumming, D. 2019. "Pleistocene Extinctions: Climate Change, Hominin Predation, or Both?" *In*: Wilson, J.W., and Primack, R.B. *Conservation Biology in Sub-Saharan Africa*. Open Book Publishers. p 263.

Cunningham, S. 2019. "Desert Birds and Climate Change." *In*: Wilson, J.W. and Primack, R.B. *Conservation Biology in Sub-Saharan Africa*. Open Book Publishers. p 179.

Dean, W.R.J., Melo, M., Mills, M.S.K. 2019. "The avifauna of Angola: richness, endemism and rarity". *In*: Huntley, B.J. et al. *Biodiversity of Angola: science & conservation: a modern synthesis*. Cham, Switzerland: Springer Open. pp 335-356.

Ryan, P. 2019. "Aliens on Islands: Damage and Control." *In*: Wilson, J.W. and Primack, R.B. *Conservation Biology in Sub-Saharan Africa*. Open Book Publishers. p 233.

Seymour, C. and Joseph, G. 2019. "Ecology of smaller animals associated with savanna woody plants: the value of the finer details." *In*: Scogings, P. F., and Sankaran, M. *Savanna woody plants and large herbivores*. Hoboken, New Jersey: Wiley. pp 181-211.

Wanless, R. "Solving Seabird Bycatch Problems: From Theory to Practice." *In*: Wilson, J.W. and Primack, R.B. *Conservation Biology in Sub-Saharan Africa*. Open Book Publishers. p 221.

Key 2019 supporters

The FitzPatrick Institute is extremely grateful for the generous support from co-supporters. Without this support it would not e possible to maintain our high levels of research, teaching and scientific output.