FitzPatrick Institute of African Ornithology

DSI - NRF Centre of Excellence

University of Cape Town

Annual Report 2023

FRONT COVER: 2023 was the 23rd year of the Fitz's APNR Ground-Hornbill Project in the Associated Private Nature Reserves adjacent to Kruger National Park. The Southern Ground-Hornbill *Bucorvus leadbeateri* is listed as 'Vulnerable' internationally, and 'Endangered' within South Africa. The work of the APNR Ground-Hornbill Project continues to improve our understanding of the biology and ecology of this and other cooperatively-breeding species, and through provision of nestboxes has been instrumental in turning around the population decline of the birds in the study area. Current research on the population is helping us understand the birds' behavioural and physiological responses to climate warming and the likely threat this poses to the population. This photo was taken in the early days of the project by Prof. Phil Hockey.

REPORT LAYOUT: HILARY BUCHANAN

Contents

Director's report

The FitzPatrick Institute underwent a significant period of transition in 2023. We experienced simultaneous changes in leadership, staffing and our dominant funding model during this year. We also graduated a bumper crop of students and made significant progress in our physical recovery from the COVID-19 pandemic, now becoming (thankfully) a distant memory. Student life began to return to 'normal' with a buzz in the corridors again, aided by our efforts to repaint and refurbish our workspaces, hang new pictures and establish new social initiatives. We also completed a Fitz Handbook and Fitz Finance Manual to help our students and staff navigate their time here at the Fitz. Throughout all the changes, we maintained our tradition of research excellence, with > 100 papers published in 2023, including in some of the world's top journals (e.g. *Science, Nature Communications, Nature Ecology & Evolution, Global Change Biology* etc.), and core research programmes continued in the post-CoE era.

A/Prof. Susan Cunningham

Leadership and staffing changes:

Prof. Peter Ryan retired as the Director of the Fitz at the end of 2022, ending a decade of service in the role. Peter became Acting Director after the passing of Phil Hockey in 2013, and formally the Director in 2014. In the first years of his directorship, Peter led the appointment of a new generation of academic staff at the Fitz, including hiring A/Prof. Robert Thomson to a core academic role, Prof. Claire Spottiswoode to the Pasvolsky Chair of Conservation Biology, and myself to the role of Conservation Biology MSc convenor, a post he soft-funded from the Centre of Excellence (CoE) grant. He also oversaw the recruitment of new support staff, including two generations of Chief Technical Officers (Gonzalo Aguilar, followed by Michael Brooks) and Niven Librarians (Susan Mvungi, followed by Janine Dunlop). Peter was also in charge when the Fitz took over the management of the citizen science databases formerly run by the Animal Demography Unit (ADU), including the Southern African Bird Atlas Project (SABAP) and South African Bird Ringing Unit (SAFRING).

During Peter's watch, the Fitz achieved considerable international success as a research institute. From 2016-2022 the Fitz published >100 papers annually in peer-reviewed scientific journals, with the quality and impact of those publications steadily rising throughout that time. In 2017, UCT was ranked joint 3rd in the world for ornithology by the Center of World University Rankings on the strength of this output. Peter himself achieved an A-rating from the NRF (the first ornithologist ever to do so), and continued to publish ~30 papers per annum, despite the demands of the Directorship! We thank Peter for his immense efforts and successes in the role and wish him a productive and happy retirement as Emeritus Professor and Senior Scholar.

2023 began with Prof. Claire Spottiswoode in the role of Acting Director. The process of appointing a new Director was protracted, but I was finally offered and accepted the post in March 2023, taking over the reins in April. I would like to thank Claire for ensuring the smooth running of the Institute during the Directorship recruitment process. Claire was also instrumental in reigniting a warm and welcoming social culture at the Fitz post-COVID-19, which assisted in encouraging everyone to return to office life. I tried to persuade her to stay on in the Director role, but she refused!

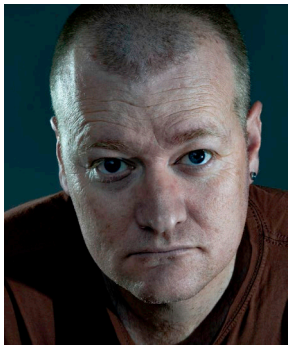
Taking on the Directorship meant that, like Peter before me, I relinquished the convenorship of the Conservation Biology MSc course. One of my first challenges, before I even signed the contract, was to find a replacement for this role. We were fortunate that Dr Sally Hofmeyr was available to take over at short notice on a part-time, fixed-term basis, ensuring stability for this important flagship course until the end of 2024. Sally hit the ground running and did an excellent job in 2023. At the time of writing, she has successfully shepherded the 2023 cohort to completion and launched the 2024 cohort into their studies.

We welcomed Michael Brooks as Chief Technical Officer in early 2023 after the retirement of Gonzalo Aguilar. A restructuring of the role by Peter Ryan and the Biological Sciences HoD Prof. Tony Verboom, allowed Michael to take on technical support for the Fitz and Biological Sciences, while maintaining his long-standing work in IT support and database management for the citizen science projects. Michael quickly made his mark, developing a new system for inventorying and booking Fitz field equipment (including vehicles) and sorting out many decades' worth of accumulation to restore our equipment and sample storage spaces to functionality. Michael, together with Janine Dunlop, Susan Miller, Rebecca Muller and many others, has also contributed heavily to the revitalisation of the Fitz's public spaces. Furthermore, he has improved the safety, roadworthiness and financial sustainability of the Fitz vehicle fleet. We thank both Michael for his excellent work to date, and Gonzalo for his many years of dedicated service.

Maintenance of the citizen science programmes, in particular the citizen science liaison and outreach roles for SABAP2, were further assured when Tania Anderson joined the team at the beginning of the year in a part-time position. Tania has done an excellent job fielding requests and maintaining the public presence of SABAP2, with her successes reflected in very healthy numbers of atlas cards submitted during the year and the increasingly youthful profile of the atlassing community. Tania also provides administrative support to the SABAP2 Steering Committee and a strong liaison between the Fitz and BirdLife South Africa partners in this important project. Well done and thank you, Tania.

In terms of staffing, 2023 was also notable for being Hilary Buchanan's last year as the Fitz's Administrative Assistant. Hilary's role includes all aspects of student administration including the Conservation Biology MSc course, assistance to the Director and core administrative work necessary to the functioning of the Fitz. As the first port of call, she is well known to all the Fitz's partners, national and international. Hilary first joined the Fitz family during Morne du Plessis's tenure as Director, in 2000. Hilary's efficiency, competence, and compassion made her the heart of the Fitz over her more than two decades in this very central role, and very much our matriarch. Generations of students and post-docs have successfully completed their time at the Fitz under her care, and we will miss her sorely. Hilary officially retired at the end of 2023 but has stayed on until the time of writing (March 2024), while we complete the process of hiring a new Administrative Assistant who will start in April.

Dr Sally Hofmeyr



Michael Brooks

Tania Anderson

Hilary Buchanan

Funding models: a new era:

For two decades, the Fitz has enjoyed stable research funding as a DSI-NRF Centre of Excellence. Due to economic pressures faced by the NRF, exacerbated by the COVID-19 pandemic, this programme was finally wrapped up in 2022. The Fitz's CoE contract officially ended in September 2023. The CoE chapter in this report (page 6) shows the incredible impact of the 19 years of flexible funding, which has left a strong tradition of excellence firmly embedded in the Fitz's culture. Many of the project pages in this Annual Report acknowledge the CoE funding for the last time. The final spend-down and wrap up of this grant was ably handled by Dr Susan Miller with assistance from Fitz finance administrator Anthea Links – thank you both for this immense effort.

The future of the Fitz as a research institute on the international stage remains bright as we emerge from the CoE era. Over the last five years, external non-CoE research funding has outstripped the CoE two-to-three fold. This success in obtaining external funding provides stability for our core research programmes, most of which will continue into 2024 and beyond under new funding models. The books for 2023 inevitably reflect a decline in overall income with the loss of the CoE, but we anticipate funding levels to recover to those enjoyed during the CoE era over the next two to three years, due to exciting new developments on the horizon.

Another corollary of the end of the CoE is that the Fitz has moved back onto the University Research Council's (URC) accreditation and review cycles. During the tenure of the CoE, external review of the Institute was carried out through the CoE programme. This means the outputs and trajectory of the Fitz will now be reviewed every five years by a panel of international reviewers convened through UCT (rather than the DSI-NRF). In October 2023, the Fitz underwent its first URC review in 20 years. This resulted in confirmation of our accreditation as an Institute, which remains valid for the cycle 2024 – 2029.

Students and the 'life of the Fitz':

The Fitz graduated a bumper crop of 34 students in 2023, 5 PhDs, 4 MSc-by-dissertation, and 25 MSc Conservation Biology by coursework and dissertation students. Four BSc Hons students also successfully

completed the research components of their degrees under Fitz supervision. The large number was in part due to the graduation of the pandemic-delayed 2021/22 cohort of CB MSc students alongside the 2022/23 cohort. We welcomed relatively few new students in 2023 but anticipate enrolments will increase again in 2024 as new funding sources become available.

Alongside this bumper graduation, we made a concerted effort to accelerate our recovery from the Covid-19 pandemic and restore the 'joie di vivre' to the corridors of the Fitz. Initiatives included the restoration of Fitz tea at 10:30am initially on Tuesdays and Thursdays and then daily; and the launch of "Thirsty Thursdays" – social drinks in the Niven Library every second Thursday afternoon, to make up for the pandemic-related closure of the UCT Club and consequent lack of a venue for casual social gatherings at the end of the week. Many thanks are due to the post-doc and student volunteers running these initiatives, with special mention of Chris Vennum and Kyle Walker.

We also put effort into increasing the warmth and relevance of the Fitz's physical space for its current and future occupants. Climbing the stairs from the Niven Library, one is now welcomed by colourful pictures of Fitz students, staff and research associates in the field, reflecting our vibrant community and the work we do. We created a 'Heritage Gallery' in the admin office area, to provide a dedicated space to display portraits of key donors and provide information around the founding of the Fitz, its historic and current work, and the people and partner organisations involved. Janine Dunlop, the Niven Librarian, is curating this space, which we expect to continue to evolve. We sourced group photos of every Conservation Biology MSc cohort to date and hung these outside the Niven Library, where current and former students can easily find them. We're really excited about the 'new look' Fitz and hope we will be able to continue to modernise the space in the coming years and keep things fresh and up to date.

Finally, in 2023 we completed and launched the 'Fitz Handbook' and 'Fitz Finance Manual'. These are live documents hosted online and continually updated, which provide guidance and support for new and established Fitzies alike to navigate the structures of the Fitz and UCT and ensure their time here is a success.

Conclusion:

During 2023, the Fitz continued to uphold its culture of research excellence. Our publication record was excellent, and we added to our superb network of Research Associates and Honorary Research Associates around the world. Peter Ryan and Claire Spottiswoode were both awarded A-ratings by the NRF in 2023, indicating their status as world leaders in their respective fields of research. Congratulations to both of them! The majority of the Fitz core academic staff are now either A- or B-rated by the NRF, reflecting the considerable international recognition of the work carried out by the team. The life of the Fitz was substantially restored in 2023 as we emerged – finally – from the pandemic era. I am excited to welcome our incoming cohorts of bright and talented post-graduate students and post-docs from South Africa, Africa, and around the world in 2024 and beyond. Amid a rapidly changing world and all the myriad challenges of the 21st Century, we have a fantastic team and, therefore, a bright future.

Susan Cunningham, March 2024

FITZPATRICK INSTITUTE ADVISORY BOARD 2023

Mark Anderson (BirdLife South Africa)
Dr Graham Avery (WESSA)
Dawie Chamberlain (co-opted)
Dean Ferreira (co-opted)
Vernon Head (co-opted)
Prof. Maano Ramutsindela (Dean of Science) Jan-June
François van der Merwe (co-opted)
Prof. Patrick Woudt (Interim Dean of Science) July-Dec
A/Prof. Pippin Anderson (ENGEO, UCT)
Michael Buckham (co-opted)
A/Prof. Susan Cunningham (Director, FIAO) Apr-Dec
Prof. Sue Harrison (DVC Research, UCT)
Marina Niven (FitzPatrick Memorial Trust)
Prof. Claire Spottiswoode (Acting Director, FIAO) Jan-Mar
A/Prof. Tony Verboom (HoD, Biological Sciences)

CENTRE OF EXCELLENCE STEERING COMMITTEE 2023

Prof. Mike Cherry (U. Stellenbosch)
Dr Theressa Frantz (SANBI)
Dr Vusi Malele (DSI)
Dr Linda Mtwisha (UCT)
Prof. Maano Ramutsindela (UCT) Jan-June
Prof. Claire Spottiswoode (FIAO) Jan-Mar
Dr Hanneline Smit-Robinson (BirdLife South Africa)
A/Prof. Susan Cunningham (Director, FIAO) Apr-Dec
Prof. Sue Harrison (DVC Research, UCT)
Rose Msiza (DSI)
Emer. Prof. Peter Ryan (FIAO)
Nathan Sassman (NRF)
Dr Yonah Seleti (DSI)

Staff, Students and Associates

UCT GRADUATES

PhD

Timothy Aikins Khan
Daniël Cloete
Kyle-Mark Middleton
Angela Moreras
Miqkayla Stofberg

MSc

Taylyn Risi
Rochelle Mphetlhe
Sanjo Rose
Michelle Vrettos

Conservation Biology MSc

Michelle Bouwer
Bruce Chrispo
Kim Daniels
Emma Fagan
Jarryd Foster
Shaidan Gonlag
Kyle Hinde
Sean Morar
Ella Mutch
Kim Parker
Nomasonto Skosana
Marileen vd Westhuizen
Emma Wright
Hal Brindley
Amy Cooper
Jane Doherty
Sara Forsberg
Bianke Fouche
Jo Hawker
Matt Lobenhofer
Charles Mpofu
Amana Othman
Joseph Sekyanzi
Johan vd Westhuizen
Kayla Webster

NEW UCT STUDENTS

MSc

Yinka Abayomi (Chima Nwaogu/Claire Spottiswoode)
Sthabile Khumalo (Celiwe Ngcamphala/Robert Thomson)

Upgrade from MSc to PhD

Kyle Maclean

Conservation Biology MSc

Thirteen students began the CB MSc in January 2023.

BSc Hons

Rebecca Irons (Robert Thomson)
Daniella Mhangwana (Claire Spottiswoode)
Joel Radue (Claire Spottiswoode)
Martiné van den Berg (Susie Cunningham)

Academic Staff

Director:

Prof. Claire Spottiswoode, PhD (Cambridge) (Acting, Jan-Mar)
Assoc. Prof. Susan Cunningham, PhD (Massey)(Apr-Dec)

Academic and Research Staff:

Assoc. Prof. Arjun Amar, PhD (Aberdeen)
Dr Sally Hofmeyr, PhD (Cape Town)
Dr Chima Nwaogu, PhD (Groningen & St Andrews)
Emer. Prof. Peter Ryan PhD (Cape Town)
Prof. Claire Spottiswoode, PhD (Cambridge)
Assoc. Prof. 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)
Prof. Wendy Foden, PhD (Wits)
Dr David Grémillet, PhD (Kiel)
Dr Azwianewi Makhado, PhD (Cape Town)
Dr Megan Murgatroyd, PhD (Cape Town)
Dr Patrick O'Farrell, PhD (Cape Town)
Assoc. Prof. Mandy Ridley, PhD (Cambridge)
Dr Andrea Santangeli, PhD (Helsinki)
Dr Colleen Seymour, PhD (Cape Town)
Dr Rob Simmons, PhD (Wits)
Dr Ross Wanless, PhD (Cape Town)

Research Associates

David Allan, MSc (Cape Town)
Dr Ben Ashton, PhD (Western Australia)
Dr Steve Boyes, PhD (KwaZulu-Natal)
Dr Christiaan Brink, PhD (Cape Town)
Dr Callan Cohen, PhD (Cape Town
Dr Maëlle Connan, PhD (Pierre & Marie Curie)
Dr Timotheé Cook, PhD (La Rochelle)
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 Anthony Lowney, PhD (Cape Town)
Dr Kristi Maciejewski, PhD (NMU)
Dr Rowan Martin, PhD (Sheffield)
Dr Martim Melo, PhD (Edinburgh)
Dr Antoni Milewski, PhD (Murdoch)
Prof. Sue Milton, PhD (Cape Town)
Dr René Navarro, PhD (Cape Town)
Dr Samuel Osinubi PhD (Christchurch)
Adj. Prof. Lorien Pichegru, PhD (Strasbourg)
Dr Dominic Rollinson, PhD (Cape Town)
Dr Yan Ropert-Coudert PhD (NIPR, Tokyo, Japan)
Dr Antje Steinfurth, PhD (Kiel)

Dr Petra Sumasgutner, PhD (Vienna)
Dr Gareth Tate, PhD (Cape Town)
Jessie Walton

Post-doctoral fellows
Dr Shannon Conradie, PhD (Pretoria)
Dr Jessica van der Wal, PhD (St Andrews)
Dr Chris Vennum, PhD (Colorado State) Jan - July

Support Staff

Manager, DSI-NRF CoE
Dr Susan Miller, DTech (TUT)

Principal Technical Officer
Michael Brooks

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

Niven Librarian
Janine Dunlop, M.IT (Lib Sci) (Pretoria)

Project Assistants
SABAP2: Sanjo Rose, BSc (Hons) (Cape Town) Jan-June
SAFRING: Kim-Kelly Hunt, MSc (Cape Town)

Ad hoc Research Assistants
Cayla Aitchison; Shonese Bloy; Daniël Cloete Rion Cuthill; Karis Daniel; Jane Doherty; Robin Fourie; Sally Hofmeyr; Amy Hunter; Andrew Jackson; Mpho Lavengwa; Jess Lund; Phomelelo Malatji; Latoya Ndlovu; Ben Murphy; Olufemi Olubodun; Natasha Pindral; Natasha Shilubane; Christopher Shortland; Michelle Vrettos; Samantha Wagstaff; Kayla Webster.

Students

Doctoral
Timothy Aikins Khan, MPhil (Ghana)
Daniël Cloete, MSc (Cape Town)
Robin Colyn, MTech (CPUT)
Christie Craig, MSc (Cape Town)
Carrie Hickman, BSc (Hons) (Open University)
Eliupendo Laltaika, MSc (Cape Town)
David Lloyd-Jones, BSc (Hons) (Canterbury)
Kyle-Mark Middleton, BSc (Hons) (Pretoria)
Angela Moreras, MSc (Bielefeld)
Rebecca Muller, MSc (Cape Town)
Benjamin Murphy. MSc (Exeter)
Merlyn Nkomo, MSc (Cape Town)
Olufemi Olubodun, MSc (Ibadan)
Kailen Padayachee, BTech (TUT)
Nicholas Pattinson, MSc (NMU)
Vonica Perold, MSc (Pretoria)
Kim Stevens, BSc (Hons) (Cape Town)
Miqkayla Stofberg, BSc (Hons) (Cape Town)
Marc Travers, MSc (Simon Fraser)

MSc by dissertation
Temitope Adelola, BSc (Hons) (Akure)
Abiodun Ademola, BSc (Hons) (Abeokuta)
Cameron Blair, BSc (Hons) (Cape Town)
Kyle Maclean, BSc (Hons) (Cape Town)
Rochelle Mphetlhe, BSc (Hons) (Botswana)
Chukwudi Nwaigwe, BSc (Hons) (Futo)
Koi Pillay, BSc (Hons) (Cape Town)
Taylyn Risi, BSc (Hons) (Cape Town)
Sanjo Rose, BSc (Hons) Cape Town)
Michelle Vrettos, BSc (Hons) (Cape Town)
Kyle Walker, BSc (Hons) (Cape Town)

Masters in Conservation Biology 2023/24
Tevin Adams, BSc (Hons) (Western Cape)
Zoe Allouchery, BSc (Hons) (Cape Town)
Abigail Campbell, BSc (U.Mass Amherst)
Alexandro Faria, BSc Agric (Hons) (Pretoria)
Mpho Havhi, BSc (Hons) (Venda)
Wiro-Bless Kamboe, BSc (U. Dev. Studies)
Casper Morch, BSc (Leiden Univ. College)
Choolwe Mulenga, BSc (Copperbelt, Zambia)
Maggie Mwale, BSc (Copperbelt, Zambia)
Obakeng Pule, BSc (Hons) (North West)
Lawrence Steyn, BCom (Pretoria)
Wambui Waibochi, BSc (Hons) (East Anglia)
Robi Watkinson, BSc (Leeds)

Masters in Conservation Biology 2022/23
Michelle Bouwer, BSc (Hons) (Pretoria)
Harold Brindley, BA (William & Mary)
Bruce Chrispo, BSc (Mweka)
Amy Cooper, BSc (Stellenbosch)
Kim Daniels, BSc (Hons) (Western Cape)
Emma Fagan, MBChB (Cape Town)
Jarryd Foster, BSc (Hons) (Stellenbosch)
Bianke Fouche, BSc (Hons) (NMU)
Shaidan Gonlag, BSc (Hons) (Stellenbosch)
Matt Lobenhofer, BSc (Suny)
Ella Mutch, BSc (Plymouth)
Amana Kilawi Othman, BSc (Mweka)
Johan van der Westhuizen, BSc (Stellenbosch)
Marilize van der Westhuizen, BSc (Stellenbosch)

Masters in Conservation Biology 2021/22
Jane Doherty, BVetSci (Onderstepoort)
Sara Forsberg, BSc (Norwegian University of Life Sciences)
Johanna Hawker, BSc (Hons) (Durham)
Kyle Hinde, BSc (Hons) (Stellenbosch)
Sean Morar, BSc (Hons) (Wits)
Charles Mpofu, BSc (Botswana)
Kim Parker, BSc (Hons) (Rhodes)
Joseph Sekyanzi, BSc (Makerere, Uganda)
Nomasonto Skosana, BSc (Hons) (Limpopo)
Kayla Webster, BSc (Stellenbosch)
Emma Wright, BSc (Hons) (Wits)

BSc Hons
Rebecca Irons, Daniella Mhangwana, Joel Radue, Martiné van der Berg

Externally registered students

Doctoral:
Cambridge –Tanmay Dixit, Jess Lund
Helsinki – Teresa Abaurrea
Leeds – Rebecca Dobson
Montpellier –Nicolas Silva
NMU – Danielle Keys
Porto –Babette Fourie, Marta Marmelo
Pretoria –Ryno Kemp, Wesley Gush
UCT – Jessleena Suri (Stats)
Western Australia – Emily Stott

MSc/MPhil by dissertation:
Cambridge – Mairenn Collins Attwood, Rion Cuthill
Porto –Mariana Sousa
NMU –Lyle de Menezes, Tegan Walker
Pretoria – Bianca Coulson, Nazley Liddle**,** Otto Makola, James Short, Lara Strydom, Jaimie Whyte

BSc Hons
Pretoria – Jochen Voges

CoE research and education highlights

The FitzPatrick Institute CoE Birds contract ended in mid-September 2023 after 19 years of funding. Over 300 students graduated, 55 post-docs were hosted and international collaborations increased resulting in over 1900 publications in peer-reviewed journals. The international reputation of the Fitz was recognized in 2017 when UCT was ranked joint third in the world for Ornithology by the Center for World University Rankings. The legacy of the CoE funding has left a strong culture of sustained, high-level performance within the Fitz that will ensure the continued success of the Fitz for many years to come.

The DSI-NRF Centre of Excellence *Biodiversity Conservation: Birds as Keys to Understanding and Maintaining Biodiversity* (CoE Birds) was formed in 2004 out of the FitzPatrick Institute of African Ornithology (FIAO) at the University of Cape Town (UCT) and selected research partners at other South African universities. Financial support continued for 19 years until 2022, with 84% of funding allocated to student bursaries and running costs. The CoE birds was initially funded for five years, but this funding was extended three times due to the excellent performance of the CoE. During the final 5-year tranche of funding, the economic impact of the Covid-19 pandemic and changing funding landscape at the NRF prompted changes to the CoE's programme, including the wind-up of the original six CoEs (of which the CoE Birds was one).

The 19 years of secure CoE funding allowed Fitz academics to concentrate on their research programmes, resulting in a world-class research centre. It also facilitated many collaborations with researchers based at institutions overseas, which strengthened the academic programmes at all participating South African institutions (Fig 1).

The CoE funding spanned four Fitz Directors: Morné du Plessis (2004-2007), Phil Hockey (2007-2013), Peter Ryan (2013-2022) and Susie Cunningham (2023–current). Claire Spottiswoode must be mentioned for her efforts as Acting Director when Peter retired at the end of 2022. Claire ably steered us through the first months of 2023 before Susie was appointed as the new director in April 2023.

Two broad research themes were established in the initial proposal for the CoE Birds: Maintaining

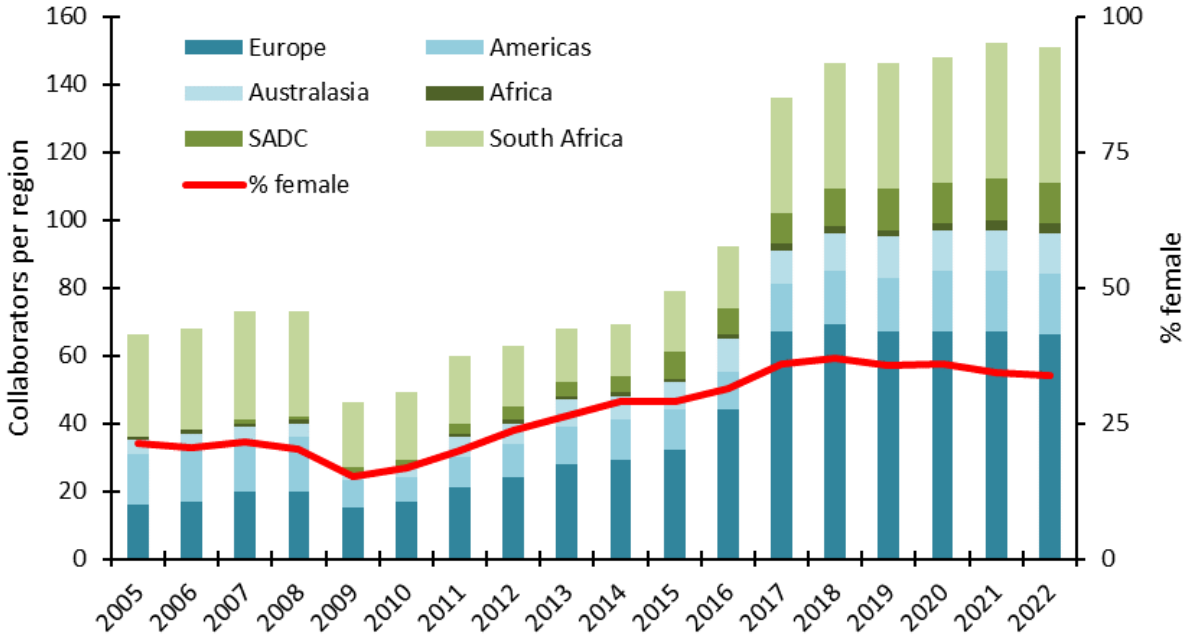


Fig 1: Numbers of collaborators over time by region and gender

Fig 2. Peer-reviewed publication output of the CoE over the years. Impact factors are indicated in the legend with darker colours indicating higher impact factors.

Biodiversity and Understanding Biodiversity. Multiple research programmes were established under these two themes over the lifetime of the CoE Birds, most of which are still active post-CoE. Many other smaller projects supplemented these programmes, contributing to an impressive output of over 1 900 peer-reviewed papers. These programmes have benefited from collaborations with researchers at a wide range of universities, NGOs, government departments and other relevant parties, and have trained a high calibre of students and postdoctoral fellows, ensuring the continuation of world-class research.

Much was accomplished during the 19 years of CoE funding. The Fitz already enjoyed many strong links internationally, but the CoE helped foster links with other South African institutions. Over 300 students graduated and 55 post-docs were hosted at the Fitz during the CoE era. With increasing student supervision and good numbers of post-doctoral fellows, scientific outputs increased steadily throughout the life of the CoE. This was reflected not only in the number of papers published each year, but also the calibre of the journals in which they were published. The high proportion of papers in high impact journals reflects the quality and relevance of the research conducted by the CoE team (Fig 2). The success and international reputation of the FIAO was recognized when the Centre for World University Rankings (CWUR) released their inaugural subject rankings in April 2017, where UCT was joint third in the discipline Ornithology out of over 26 000 higher education institutions.

The legacy of the CoE funding has resulted in a strong culture of sustained, high-level performance within the Fitz that is transferred from the academic staff to the students and that will ensure the continued success of the Fitz for many years to come.

Coevolutionary arms races in brood-parasites and their hosts

Coevolution is the process by which two or more species influence each other's evolution. Brood-parasitic birds, the cheats of the bird world, give us an ideal opportunity to study coevolution in the wild. Coevolutionary "arms races" arise when 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.

Claire Spottiswoode's team works on a variety of brood-parasitic systems in Zambia, focusing mainly on three broad 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 maintained? The genetic basis of signature-forgery arms races is almost entirely unknown. In collaboration with Prof. Michael Sorenson (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. We are also interested in the genetic basis of host defences, and whether convergent genetic mechanisms have evolved in their parasitic mimics. Third, what is the role of phenotypic plasticity (such as developmental differences and learning) in coevolution, and how might such plasticity facilitate exploitation of new host species in the absence of appropriate genetic adaptations? We are addressing this question for indigobirds, whydahs and honeyguides.

Fitz Research Associate Jessie Walton has been studying Brown-backed Honeybirds *Prodotiscus regulus*, which parasitise Karoo Prinias *Prinia maculosa* at a high rate in the Bot River area of the Western Cape. Brown-backed Honeybirds have blue eggs, highly unusual in piciform birds, that broadly mimic the blue eggs 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.

Robert Thomson's team works 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* parasitising their nest. Hosts that are able to avoid parasites decrease the fitness costs of parasitism; the earlier that avoidance occurs during the breeding cycle, the lower the cost. Therefore, host adaptations before egg laying should be especially beneficial. The Finnish project investigates the redstart's frontline defences (nest site choice, habitat selection, nest building decisions) and the cuckoo's counter-adaptations, including prospecting and laying strategies, which have received little attention to date. Redstarts are the only regular cuckoo host that breed in cavities, which makes it difficult for female cuckoos to lay eggs and for their newly-hatched chicks to evict host eggs/chicks. This project also studies whether cuckoo females use behaviour and physiology to enhance the manipulative signals that cuckoo nestlings use to extract as much care as possible from their foster parents.

Activities in 2023

- We carried out two seasons of fieldwork in Zambia: rainy season fieldwork in January–March (Tanmay Dixit), and dry season fieldwork in September–November (Jess Lund, Mairenn Attwood, Maggie Mwale and Joel Radue), working on Cuckoo finches, honeyguides,

Collins Moya, chief field assistant to the Zambia brood parasite project since 2007, uses an 'egg spoon' to carefully remove drongo eggs from their nest for measurement (Photo: Mairenn Attwood).

African cuckoos *Cuculus gularis* and their hosts, and the thermal ecology of ground-nesting birds, together with our local field team led by Collins Moya, Silky Hamama and Onest Siakwasia.

- Gabriel Jamie (Fitz Research Associate) carried out a successful season of wide-ranging fieldwork in Zambia as part of his Leverhulme Early Career Research Fellowship together with Professor Per Alström (Uppsala University) and Professor Urban Olsson (Gothenburg University). Gabriel is exploring the evolution of polymorphisms across the Cisticolidae family which exhibit some of the most complex and diverse eggs of any group of birds in the world. This includes sampling species and populations that have rarely, if ever, been sequenced before.
- Maggie Mwale (CB MSc) and Joel Radue (BSc Hons) joined the Choma field team for their research projects on different aspects of the thermal ecology of ground-nesting birds in Zambia, and how this may trade-off against egg camouflage against predators. Their projects were co-supervised by Claire Spottiswoode and Shannon Conradie at the Fitz, and Nicholas Horrocks at the University of Cambridge.
- Robert Thomson visited the field site in Finland during June and July to continue the long-term monitoring of cuckoo parasitism of the redstart population. Extremely high nest predation rates of redstart nests (~90% of nests) caused havoc during the season.

Highlights

- Angela Moreras was awarded her PhD during 2023 for her thesis entitled "Frontline strategies in the arms race between hosts and their brood parasites: the case of the common redstart." Angela was also awarded the 2023 Faculty of Science Purcell Memorial Prize. The prize is awarded annually for the best MSc or PhD thesis in a zoological study area at UCT.
- Mairenn Attwood, together with colleagues from the Fitz and Choma field team, published a paper "Aggressive hosts are undeterred by a cuckoo's hawk mimicry, but probably make good foster parents", in *Proceedings of the Royal Society B*. The paper investigated the costs and benefits to the African cuckoo of specializing on a highly

aggressive host species, the Fork-tailed Drongo *Dicrurus adsimilis*, using field experiments in Zambia. It showed that aggression can exacerbate the trade-off a parasite faces in choosing which host species to parasitise: drongo aggression undermined the effectiveness of hawk mimicry, but drongo nest survival was high relative to other potential host species with similar nesting ecology, suggesting that successful parasites secure high-quality care for their offspring.

- Jess Lund, also together with colleagues from the Fitz and Choma field team, published a paper in *Proceedings of the Royal Society B*: "When perfection isn't enough: host egg signatures are an effective defence against high-fidelity African cuckoo mimicry". The paper shows that African cuckoos mimic all egg types of their fork-tailed drongo hosts, and do so with near-perfect accuracy. However, the high degree of variability in appearance of drongo eggs – creating individually-distinctive egg 'signatures' – means that drongos have the upper hand in the arms race against their parasite. Jess's paper was featured on some prominent media including *The Guardian* and *New Scientist*.
- Gabriel Jamie gave the Hemborg Lecture at Uppsala University in Sweden, an annual lecture honouring the memory of Dr Christer Hemborg, a former postdoc at the Fitz. Gabriel's lecture was entitled "The evolution of nestling ornamentation".
- Tanmay Dixit (Fitz Research Associate) published a paper in *Biology Letters* entitled "Combined measures of mimetic fidelity explain imperfect mimicry in a brood parasite-host system". This study was part of a collaboration between our group and Prof. L. Mahadevan and his lab at Harvard University. Together we combined mathematical tools and field experiments in Zambia to quantify a key difference – "squiggle" markings – between the eggs of hosts (tawny-flanked prinias) and parasites (cuckoo finches). We showed that suboptimal behaviour on the part of prinias allows cuckoo finches to get by with an imperfect copy of prinia eggs.
- Tanmay and collaborators published a paper in *Evolution* entitled "Repeatable randomness, invariant properties, and the design of biological signatures of identity". The study uses methods from applied maths and computer science to predict the properties of egg signatures that hosts (tawny-flanked prinias) should use when detecting parasitic (cuckoo finch) eggs in their nests, and test this experimentally against the reality in the field in Zambia. The paper also introduces a new method for "unwrapping" the patterns on a 3D egg onto a 2D plane for analysis.
- Tanmay, together with Fitz and Choma colleagues and others including several computer scientists, published a paper in *Nature Ecology and Evolution* showing how rapid coevolution of both tawny-flanked prinia eggs and their cuckoo finch mimics means that mimicry doesn't get any better over time.
- Tanmay published a paper in *Evolution* entitled "A synthesis of coevolution across levels of

Two clutches of Fork-tailed Drongo eggs parasitised by African Cuckoos in Zambia. In each case the cuckoo egg is at lower right (Photo: Jess Lund).

Individual egg 'signatures' of different Fork-tailed Drongo females in Zambia, that help them to defeat egg mimicry by parasitic African Cuckoos (Photo: Jess Lund).

Zambia field team participating in Global Bird Weekend: Silky Hamama, Collins Moya, Onest Siakwasia, Joel Radue and Maggie Mwale (Photo: Mairenn Attwood).

biological organization". In it, he argues that we must extend the definition of coevolution, beyond reciprocal adaptive evolution of different species, to encompass all examples of reciprocal adaptive evolution, including those between traits within a species.

- Tanmay passed his PhD at the University of Cambridge with no corrections – a very rare achievement. His thesis entitled "Signatures and forgeries: optimality in a coevolutionary arms race" was based on his work in the Zambia brood parasite team. Tanmay then began his Junior Research Fellowship at University of Cambridge, continuing his work in Zambia, and remains a Research Associate at the Fitz.
- Jess Lund was awarded an R. C. Lewontin Graduate Research Excellence Grant from the Society for the Study of Evolution which will enable her to expand her investigations into the fascinating double lives of honeyguides as parasites and mutualists.
- The Zambia brood parasite team continued their diverse outreach and collaborative activities internationally, including presenting talks to schools in both Zambia and the UK. Tanmay Dixit was again a co-presenter of the "Evolution Crash Course" online course for students in the Global South.

Key co-supporters

Biotechnology and Biological Sciences Research Council; The Leverhulme Trust; Natural Environment Research Council; Societas pro Fauna et Flora Fennica; Finnish Cultural Foundation; LUOVA Doctoral Programme in Wildlife Biology at the University of Helsinki.

Research team 2023

Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
A/Prof. Robert Thomson (FIAO, UCT)
Dr Gabriel Jamie (U. Cambridge/FIAO, UCT)
Prof. Michael Sorenson (Boston University)
Prof. L. Mahadevan (Harvard University)
Dr Nicholas Horrocks (University of Cambridge)
Dr Christopher Town (University of Cambridge)
A/Prof. Rose Thorogood (U. Helsinki, Finland)
Dr Jere Tolvanen (U. Oulu, Finland)
Jessie Walton (FIAO, UCT)

Students: Teresa Abaurrea (PhD, U. Helsinki); Mairenn Attwood (PhD, Cambridge); Tanmay Dixit (PhD, Cambridge); Jess Lund (PhD, Cambridge); Angela Moreras (PhD, UCT); Cameron Blair (MSc, UCT); Maggie Mwale (CB MSc, UCT); Joel Radue (BSc Hons, UCT).

Research assistants: *Zambia*: Silky Hamama, Collins Moya, Onest Siakwasia, Sylvester Munkonko, Sanigo Mwanza, Oscar Siakwasia, Iness Liteta, Milton Simanunki, Aron Muntanga and many others.

The evolution, ecology and conservation of honeyguide-human mutualism

This project focuses on a unique mutualism: the foraging partnership between Greater Honeyguides *Indicator indicator* and human honey-hunters who they guide 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, and provides a wonderful opportunity to study the ecology and evolution of mutualisms in nature, because human and honeyguide populations vary strikingly in how they interact, and we can readily manipulate these interactions.

Claire Spottiswoode and her team at the Fitz and the University of Cambridge 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 Begg, Keith Begg and Agostinho Jorge of the Niassa Carnivore Project. One key focus 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. The Yao honey-hunters of northern Mozambique give a loud trill followed by a grunt. A 2016 experiment showed that honeyguides were twice as likely to initiate a cooperative interaction with humans who made this sound compared to humans giving control sounds, and three times as likely to lead such humans to honey.

Supported by a Consolidator Grant from the European Research Council (as well as other grants, including the Cultural Evolution Society Transformation Fund), 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 whether 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 project, known as 'Projecto Sego' ('sego' is Greater Honeyguide in the Yao language), has the support of the community and traditional chiefs of the Mbamba and Nkuti Villages. We cooperate closely with the local community to collect data and assist with our field sampling and experiments. We also regularly carry out honeyguide fieldwork in several parts of Tanzania, again in collaboration with local honey-hunting communities, and at field sites in Zambia and South Africa. Since 2022, we have been documenting honey-hunting cultures in over ten countries as part of a Pan-African collaborative effort led by postdoctoral fellow Jessica van der Wal, funded by a Cultural Evolution Society Transformation Grant.

Activities in 2023

- David Lloyd-Jones, Jess Lund and Claire Spottiswoode carried out two successful field trips to our long-term study site at the Niassa Special Reserve in June and Nov-Dec 2023. On the latter trip, they were joined by Rion Cuthill, Lailat Guta and our close collaborator Sally Archibald from Wits.
- We welcomed Lailat Guta, a Mozambican agronomist, as a researcher on the project from November 2023 who is working on the effect of honeyguide-human mutualism on pollination

Laltaika works with field assistants Mboyo Lemoho and Lelia Olapi on calibrating his experimental playback sounds (Photo: Claire Spottiswoode).

services. Lailat will begin her MSc dissertation at the Fitz in 2024.

- Eliupendo Alaitetei Laltaika carried out fieldwork in Tanzania for much of 2023; Claire Spottiswoode and David Lloyd-Jones visited him and his team in the field in the Rungwa region in October to assist with a new field experiment.
- Rion Cuthill (BSc Hons 2021) completed his MPhil dissertation at the University of Cambridge, entitled "The ecological impacts of honey-hunting on fire regimes in the Niassa Special Reserve, Mozambique", from work together with Claire Spottiswoode, Sally Archibald, David Lloyd-Jones, and a large team of honey-hunter collaborators in Mozambique. Rion's studies were supported by a Skye Foundation Scholarship.
- Wiro-Bless Kamboe successfully completed his CB MSc research project documenting honey-hunting cultures via fieldwork in northern Ghana, supported by Jessica van der Wal's Cultural Evolution Society Transformation Grant.
- BSc Hons student Daniella Mhangwana joined the project in 2023. Daniella used camera trap data to document the surprising diversity of bird species besides honeyguides that eat and apparently digest wax, and show that these are predicted by a nectarivorous diet (which might attract them to sweet-tasting food). Daniella was supervised by Claire Spottiswoode, Celiwe Ngcamphalala and Jessica van der Wal.
- Our citizen science project, Honeyguiding.me, managed by Jessica van der Wal and Cameron Blair, continues to receive records of Greater Honeyguides, which will enable us to map the changes in the extent of guiding behaviour and help to shed light on how honeyguides acquire their ability to engage with humans (see website: AfricanHoneyguides.com).
- David Lloyd-Jones gave a talk on what honeyguides and honey-hunters have taught us about Niassa's wild honeybee ecology at the Apimondia Africa Regional Symposium held in Durban.
- Claire Spottiswoode shared the research team's findings in a talk at Harvard University (online), at the Carl Friedrich von Siemens Stiftung, Munich, Germany, as well as the plenary talk at the International Bioacoustics Conference, Sapporo, Japan.
- Jessica van der Wal shared her research findings on human-honeyguide cooperation with a talk at the Netherlands Institute of Ecology as well as a guest lecture at Wageningen University.
- Jessica van der Wal launched her new project supported by a grant from the Cultural Evolution Society (CES) Transformation Fund, entitled "A pan-African collaboration to document Africa's remaining diversity of endangered honey-hunting cultures with honeyguide birds". This allowed her to grow a collaborative network to document Africa's remaining diversity of endangered honey-hunting cultures with honeyguide birds. Thank you to the CES for this wonderful support.

Highlights

- At the Niassa Special Reserve in Mozambique, a team of five honey-hunters successfully collected a bee genetic dataset from the bee colonies they harvested, allowing us to tackle questions on the ecology of wild honeybees and how this may be affected by honeyguide-human mutualism. The team also successfully trialled the use of GPS loggers to study honeyguide spatial ecology – a long awaited dream.
- Amana Kilawi graduated with her CB MSc, receiving a distinction for her dissertation entitled "Mutualism between honeyguides, beekeepers and honey-hunters in southern Tanzania", which revealed some fascinating and unexpected cooperative interactions between honeyguides and beekeepers.
- Jessica van der Wal led a paper together with a large team of collaborators from the honeyguide research and honey-hunting research network, entitled "Do honey badgers and greater honeyguide birds cooperate to access bees' nests? Ecological evidence and honey-hunter

accounts", published in *Journal of Zoology*. Together they reviewed the evidence that honey badgers and honeyguides cooperate to access bees' nests, drawing from published accounts, their own observations, and 394 interviews with honey-hunters across nine African countries. Overall, the evidence suggests that badgers and honeyguides likely do cooperate in a restricted part of Africa, but substantial uncertainty remains. Potential cooperation between honey badgers and honeyguides may have implications for the origins of our own species' cooperation with honeyguides and for the ecology and conservation of both honey badgers and honeyguides.

- Dom Cram and other members of the honeyguide research and honey-hunter team published a paper in *Proceedings of the Royal Society of London B* entitled "Guides and cheats: producer-scrounger dynamics in the honeyguide-human mutualism". The paper investigates whether cheating honeyguides jeopardise the cooperation between honey-hunters and honeyguides, by investigating which birds guide and which birds cheat, and the pay-offs of these two tactics. Overall, the details of the honeyguide producer-scrounger system we uncovered suggest that it likely strengthens rather than jeopardises honeyguide-human mutualism.
- Claire Spottiswoode, in collaboration with Brian Wood from UCLA, published a paper in *Science* entitled "Culturally-determined interspecies communication between humans and honeyguides". The paper showed that Greater Honeyguides learn the distinct calls that honey-hunters in different parts of Africa use to communicate with them, facilitating cooperation between species. Human honey-hunters signal to honeyguides using specialised calls that vary culturally across Africa. Using field experiments in Mozambique and Tanzania, we showed that honeyguides prefer the specialised calls of the local human culture over those of a foreign culture. This implies that honeyguides can adjust to human cultural diversity, increasing the benefits of cooperation for both people and birds. The paper received much media attention internationally, including reports in *National Geographic*, *New Scientist*, and radio features on BBC and NPR.
- Jessica van der Wal and Dom Cram, together with Mauricio Cantor from Oregon State University, and assisted by Cameron Blair and Rion Cuthill, organised a hybrid Workshop on Interspecies Cooperation on 6 and 7 July in Cambridge (UK). The workshop was funded by an Interdisciplinary Workshop Grant from the Association for the Study of Animal Behaviour (ASAB), to whom we are most grateful. The workshop was a great success, with a collegial atmosphere, and 27 very interesting talks on different forms of animal-animal and human-animal cooperation, and enlightening round table discussions.

Part of the honeyguide research team at the Niassa Special Reserve, our long-term study site in Mozambique, in December 2023: Rion Cuthill, Claire Spottiswoode, Tonga Torcida from the Niassa Reserve management, David Lloyd-Jones, Sally Archibald, Eusebio Waiti of the Niassa Carnivore Project, Lailat Guta, Jess Lund (Photo: Claire Spottiswoode).

Honey-hunting research network

- George Malembo completed his MSc at Mzuzu University in Malawi, supported by the Nyika Vwaza (UK) Trust research grant and a Society for Conservation Biology Student Research Award, on honey-hunting culture in northern Malawi. He was supervised by Jessica van der Wal, Dr Lusayo Mwabumba and Dr Tiwonge Mzumara-Gawa.
- David Garakva completed his MSc at the University of Ngaoundere in Cameroon, on honey-hunting culture in the Adamawa Region in Cameroon. David's fieldwork was in part supported by the Cultural Evolution Society Transformation grant, and he was supervised by Jessica van der Wal and Dr Mazi Sanda.
- Wiro-Bless Kamboe successfully passed the coursework for his CB MSc and completed fieldwork for his thesis on human-honeyguide interactions in northern Ghana. His fieldwork

was supported by the Cultural Evolution Society Transformation grant. Wiro is supervised by Jessica van der Wal, Claire Spottiswoode and Timothy Aikins Khan.

- Six research assistants (all MSc graduates) joined the Honey-hunting research network to document remaining honey-hunting cultures in their home countries: Rochelle Mphetlhe in Botswana, Faroukou Wabi in Benin, Sanele Nhlabatsi in Eswatini, Samson Zelleke in Ethiopia and Ali Langa in Chad. This is funded by the Cultural Evolution Society Transformation Grant.
- Farisayi Dakwa, Data and Analytics Coordinator of the honey-hunting research network, developed a very useful interactive Excel template and an R Shiny App to aid data entry and visualisation, respectively, for all researchers in the network.

Impact of the project

This project closely involves rural communities and simultaneously relies on and showcases their knowledge and expertise. We hope to further our understanding of how mutualisms evolve, and specifically how learnt traits mediating mutualisms may coevolve. Understanding the evolution of mutualisms 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 disappeared 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.

Eliupendo Laltaika and David Lloyd-Jones watch a singing male greater honeyguide together with Tanzanian beekeeper Saidi Rajabu Iddy (Photo: Claire Spottiswoode).

Key co-supporters

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

Research team 2023

Prof. Claire Spottiswoode (FIAO, UCT/U. Cambridge)
Dr Susan Miller (FIAO, UCT)
Dr Dominic Cram (U. Cambridge)
Prof. Sally Archibald (Wits University)
Dr Colleen Begg (Niassa Carnivore Project)
Celestino Dauda (Niassa Carnivore Project)
Prof. Robin Crewe (U. Pretoria)
Prof. Robert Fleischer (Smithsonian Institution)
Dr Laurel Fogarty (Max Planck Institute for Anthropology, Leipzig, Germany)
Dr Celiwe Ngcamphalala (Biological Sciences, UCT)
Dr Rodrigue Idohou (Université Nationale d'Agriculture, Benin)
Dr Jessica van der Wal (FIAO, UCT)
Farisayi Dakwa (FIAO, UCT)
Assoc. Prof. Brian Wood (U. California, Los Angeles)
Prof. Timm Hoffman (Biological Sciences, UCT)
Keith Begg (Niassa Carnivore Project)
Dr Yusuf Abdullahi Ahmed (U. Pretoria)
Prof. Christian Pirk (U. Pretoria)
Dr Anne Kandler (Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany)
Dr Mazi Sanda (U. Ngaoundéré, Cameroon)
Dr Timothy Aikins Khan (University for Development Studies, Ghana)

Honey-hunting research network 2023: Anap Afan (APLORI, Nigeria); George Malembo (Mzuzu University, Malawi); Sanele Nhlabatsi (Eswatini); Wiro-Bless Kamboe (UCT); Faroukou Wabi (Benin); David Garakva (U. Ngaoundéré, Cameroon); Rochelle Mphetlhe (UCT); Ali Langa (Chad); Samson Zelleke (Ethiopia).

Students: Eliupendo Alaitetei Laltaika (PhD, UCT); David Lloyd-Jones (PhD, UCT); Jess Lund (PhD, U. Cambridge); Rion Cuthill (MPhil, U. Cambridge); Amana Kilawi (CB MSc, UCT); Wiro-Bless Kamboe (CB MSc, UCT); Daniella Mhangwana (BSc Hons, UCT).

Project Sego data collection team: Fatima Balasani, Iahaia Buanachique, Musaji Muamedi, Carvalho Issa Nanguar, Seliano Alberto Rucunua, with data collection by many others.

Cooperation and population dynamics in the Sociable Weaver

Our long-term project at Benfontein Reserve uses Sociable Weavers *Philetairus socius* and their fascinating social behaviour to study questions such as whether individuals that are more cooperative are preferred as partners, or whether sociality contributes as a buffer against the extremes of the Kalahari climate. Extreme weather has been leading to natural disasters, and fires have become more frequent in our study areas. A new line of research is investigating the social and demographic effects of natural catastrophes.

The Sociable Weavers at Benfontein have not been going through their happiest times. While the population was still recovering from a very destructive fire in 2021, another fire entered the study area in September 2023. One more colony was destroyed, adding to 9 others that had burned down in 2021 and bringing the population, which is part of a long-term study led by Rita Covas and Claire Doutrelant, to ca. 50% of what it was previously. In addition, the fire caused great damage to a set of sophisticated automatic feeders that had been built with great dedication by PhD student Babette Fourie. This led her to postpone an ambitious experiment where selected PIT-tagged birds open feeders to a group of birds or only to themselves, artificially creating 'pro-social' or 'selfish' individuals. The experiment is part of an European Research Commission (ERC) funded study that aims to assess whether individuals that are more cooperative are preferred either as sexual or social partners.

Despite its consequences, the fire created an interesting new line of investigation into how animals cope with natural catastrophes that cause sudden changes in the environment. MSc student, Mariana Sousa, used data collected pre- and post-fire to describe how the destruction of colonies caused by the 2021 fire led to a ca. three-fold increases in colony size at the surviving colonies, with an associated increase in levels of aggression. The massive immigration led also to a marked change in genetic structure at the colonies, which in turn influenced social structure. Mariana is now further exploring these results. The effects of the major stress and increased levels of aggression caused by the fire are also being studied by new post-doc Sophie Dupont, who will investigate how the fire influenced telomere attrition and survival.

PhD student, Marta Marmelo joined the project to study whether individuals differ in their propensity to cooperate and whether they help with different tasks or tend to specialise. This will help us to understand whether cooperation is a reliable trait that others can use when making decisions about who to associate with. As part of her PhD, Marta started a study of mobbing in Sociable Weavers by presenting models of snakes and Pygmy Falcons *Polihierax semitorquatus*. A different cooperative behaviour, nest building, was studied by PhD student Nicolas Silva, who found that male sociable weavers, and especially older males, prefer to build with larger straws, but females show no preference. These results are part of his first PhD paper, and part also of larger projects studying nests as extended phenotypes (French Research Agency funding) and the role of partner choice on the evolution and stability of cooperation (ERC grant).

Sociable Weavers build and maintain their nests communally throughout the year, but who builds, where and when, and - more interestingly - why, remains an elusive question. We are now recording nest building behaviour throughout the year to address these questions (Photo: Maxime Loubon).

Activities in 2023

- PhD student Babette Fourie built a sophisticated system of automatic feeders based on RFID technology to manipulate feeding behaviour and associations.
- PhD student Marta Marmelo, is investigating reliability of helping behaviour and initiated the study of mobbing behaviour in Sociable Weavers.
- Post-doc Sophie Dupont initiated a study of telomere dynamics in Sociable Weavers and will investigate how telomere attrition was influenced by the 2021 fire.
- Detailed data collection on nest building was conducted throughout the year and will be used to understand how the communal nest built by Sociable Weavers, one of the largest structures built by any animal, is achieved. These detailed data will allow us to better quantify benefits and costs of nest building.
- Data collection on social associations (feeding and roosting) was conducted during the non-breeding season for the third consecutive year. Collecting data outside the breeding period gave us crucial new insights into social structure and benefits of group membership in this species.
- Advances in video analysis led by Liliana Silva are now allowing the automatic extraction of data from videos of nest provisioning.

Highlights:

- A BBC crew filmed the sociable weavers at Benfontein as part of a new series on parental behaviour.
- Rita Fortuna published one more paper from her 2022 PhD in *Oecologica* on how egg components and offspring survival vary with group size and laying order.
- The existing long-term data on sociable weavers was included in a global study, published in *PNAS*, investigating the effect of climate change on avian offspring production.
- Liliana Silva has established a pipeline for automatic video analyses that allow to automatically identify individuals and the behaviours performed in ca. 20% of the time taken with manual analyses.

Impact of the project

The long-term nature of this project allows unique insights into the evolution of cooperation and the mechanisms that allow it to persist. The demographic data allow for examination of the factors affecting population dynamics, provide a baseline against which to study environmental change and natural disasters, which are increasing in frequency under climate change, and provide insight into whether and how sociality mediates the response to a changing environment.

Two Sociable Weavers feed at one of the project's feeding stations. These stations are equipped with RFID antennas that record the PIT-tags carried by the birds on a leg ring. The data obtained allows us to study social associations in this species and answer questions such as whether birds that cooperate more have a better social position in the colony (Photo: Cecile van Steenberg).

Key co-supporters
European Research Council (ERC); French Research Agency (ANR); Portuguese Foundation for Science and Technology (FCT).

Research team 2023

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 (CNRS, France)
Liliana Silva (CIBIO, U. Porto)
Dr André Ferreira (U. Zurich, Switzerland)
Dr Sophie Dupont (CNRS, France)

Students: Babette Fourie (PhD, Porto and Montpellier); Marta Marmelo (PhD, Porto); Nicolas Silva (PhD, Montpellier); Mariana Sousa (MSc, Porto).

Research Assistants: Franck Théron, Lesedi Moagi Carlotta Bonaldi, Paola Stefanini, Shiara Covenden, Leo Jhaveri, Antoine Grissot, Jana Rau, Anne Cillard, Rozenn LeFur, Justin Jacobs.

Pied Babblers

Since 2003, Amanda Ridley has maintained a long-term study of habituated Southern Pied Babblers *Turdoides bicolor*, on the Kuruman River Reserve in the southern Kalahari Desert. Together with her collaborators, Amanda's work explores the behavioural ecology of Pied Babblers, providing unique insight into the factors promoting conflict versus cooperation in group-living societies, life-history strategies and climate impacts. Recently, the research focus has broadened to include cognition, and more specifically, the relationship between cooperation, cognition, and climate.

The Pied Babbler Research Project investigates the costs and benefits of cooperation, and the effect of climate change on 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, as well as to determine influences on individual cognition. The study population size varies 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 the factors influencing life-time fitness. Amanda Bourne has used the long-term database to understand the impact of heatwaves and drought on survival and reproductive success. She completed her PhD in 2021, and was very productive, with several high-profile papers published from her PhD chapters, including ecological and behavioural publications in *Ecology Letters* and *Proceedings of the Royal Society B* and physiology papers in *Functional Ecology* and *Conservation Physiology.* She has also continued to produce papers into 2023. Her recent publication looked at how helper contributions to young declined during heat stress, but parent contributions did not. The Babbler team have also been 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. Camilla Soravia's PhD research has been completed and has shown that heat stress impairs some, but not all cognitive abilities in babblers. The decline in associative learning ability in the heat is of concern, because identifying the relationship between a cue and a threat is often how animals recognise competitors and predators. Camilla also found that cognitive ability declines with age in females, but not males – presumably due to the higher costs of reproduction in females. She also found that heat stress experienced during the early developmental period can have lifelong impacts, affecting reproductive success and cognition in adults.

COVID-19 had a major impact on the babbler project. Due to travel restrictions, no researcher was able to visit the babbler study site during the summer of 2020-2021. This meant that nestlings were not ringed, habituation not conducted, and groups not monitored. This is the first time the babblers have not been monitored over the summer since the project began in 2003, and is a real blow to our long-term life history database, as well as to the current state of the population. We had several field assistants attend the site at the end of 2021, but only for brief periods, and without a qualified ringer to conduct ringing. The study population now contains a lot of unringed, unhabituated individuals. For the 2022/23 breeding season, we had two researchers and an assistant on site full-time once again, and the habituation and ringing status of the population is now improving.

Activities in 2023

- Camilla Soravia remains on the project as a Postdoctoral Research fellow for a second year. Her research questions will be completed in 2024.
- Emily Stott completed a second field season at the study site, focussing on the ontogeny of cognition for her PhD research.
- New Raspberry Pi nest cameras were installed.
- Two new field assistants joined the research project.

An adult and two juvenile pied babblers. Fledglings have a prolonged period of development, and do not obtain adult plumage until about one year of age, though this varies quite a bit between individuals. Our research has shown that heat stress conditions experienced during development impacts adult cognition and reproductive success (Photo: Amanda Ridley).

Highlights:

- A paper co-authored by several Babbler Project team members and FitzPatrick Institute affiliates was published, looking at the camelthorn tree as a keystone species of vital importance for pied babblers. This was published in *Ibis*, first-authored by Kim Hunt.
- Our research on the impact of high temperatures during early development on adult cognition and reproductive success was published in *Science of the Total Environment*, first-authored by Camilla Soravia.
- Our research on the impact of heat stress on adult cognition was published in *Proceedings of the Royal Society B*, first-authored by Camilla Soravia.
- *Proceedings of the Royal Society B* published a blog post about our research described above. The blog is here: https://royalsociety.org/blog/2023/11/southern-pied-babbler-proc-b/
- Our research on the difference in declines in investment in young during heat stress between parents and helpers was published in *Behavioural Ecology*, first-authored by Amanda Bourne.
- Our research on evidence for vocal discrimination between familiar and unfamiliar kin and non-kin was published in *Animal Behaviour*, first-authored by David Humphries.
- Pied babbler research was presented at several international conferences, including a talk by Camilla Soravia at the International Society for Behavioural Ecology in Sweden.
- Amanda Ridley featured on several news, tv and documentary features talking about the principles of bird research.
- A film crew came out to the study site to film pied babbler behaviours, in particular the blackmailing behaviour by fledglings that we published on about a decade ago. A National Geographic film crew are coming out in 2024 to investigate filming possibilities with the babblers.

For more details on the collaborative work between the Pied Babbler Project and the Hot Birds Research Project, see page 41.

Key co-supporters

DSI-NRF CoE grant; Australian Research Council.

Research team 2023

A/Prof. Amanda Ridley (FIAO, UCT / UWA)
Dr Martha Nelson-Flower (Langara College)
Dr Camilla Soravia (UWA)
Dr Amanda Bourne (AWC)
A/Prof. Susie Cunningham (FIAO, UCT)
Dr Ben Ashton (UWA/Maquarie)
Dr Alex Thornton (U. Exeter)

Student: Emily Stott (PhD, UWA).

Sociable weaver nests as a resource

This project examines the importance of Sociable Weaver *Philetairus 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, challenging the traditional emphasis on negative species 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 due to global change. 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 due to global climate change.

Pygmy Falcons *Polihierax semitorquatus* are the most controversial user of Sociable Weaver colonies. They never construct their own nests and depend 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 study the natural history and ecology of Pygmy Falcons and assess whether the falcons provide benefits to the weavers.

The Kalahari Endangered Ecosystem Project (KEEP) is sponsored by Suzuki South Africa. The project uses the versatile Suzuki Jimny to check weaver colonies (Photo: Robert Thomson).

As colonial breeders, Sociable Weavers bring material back to their nest trees in the form of faeces, feathers, and carcasses. This nutrient input results in weaver nests being islands of fertility in the landscape. We study how this alters the soil chemistry, as well as soil nematode and plant communities. We further investigate the effect of this fertile island on host tree seedlings, host tree productivity and the potential costs of supporting such a huge nest.

Activities in 2023

- The 13th season of detailed monitoring of Sociable Weaver colonies and the individually marked Pygmy Falcon population at Tswalu Kalahari was completed. The 2023 breeding season featured the latest nest initiation dates of Pygmy Falcons since the monitoring started in 2011. This was also the poorest breeding season on record with only eight pairs breeding (out of ~40), and only six nestlings were ringed.
- Data collection towards the Kalahari Endangered Ecosystem Project (KEEP), a collaboration with WITS, UP, UNISA and UWC researchers, continued. These long-term data will contribute to identifying the impacts of global change on the Kalahari ecosystem.
- Robert Thomson and PhD student Olufemi Olubodun hosted a film crew from NHK (Japanese national television) on Tswalu Kalahari in December. The crew is shooting a full-length program for their Darwin's Amazing Animals series that explores the ecosystem engineering role of the Sociable Weaver and activity of other animals at their nest colonies.

Highlights:

- Timothy Aikins Khan submitted his thesis for examination in February 2023 and graduated

The NHK crew filming Robert Thomson at the field site in Tswalu Kalahari (Photo: Maurice Marell).

with his PhD in December 2023. He has since returned to Ghana where he works as a Lecturer at the University for Development Studies in Tamale.

- Olufemi Olubodun published his first PhD chapter in the *Journal of Ornithology.* This study examined the variation in some breeding parameters of the pygmy falcons over a ten-year period between 2011 and 2020.
- Anthony Lowney and Robert Thomson published a paper in *Ibis* that investigated the cost and benefits to Sociable Weavers of hosting Pygmy Falcons.
- Timothy Aikins Khan published two papers from his PhD thesis. The first paper, published in *Journal of Arid Environments* explored the "islands of fertility" created by savanna trees and how these are amplified by Sociable Weaver colonies. The second paper was published in *Plant Ecology*. Timothy established that all savanna islands of fertility are not equal but colonial birds influence soil nutrient stoichiometries with consequences for tree seedling growth. Both papers were co-authored by Prof. Michael Cramer and A/Prof. Robert Thomson.

Impact of the project

This project provides unique insights into the community ecology and between-species interactions in the Kalahari. It highlights fascinating natural history stories and brings attention to this unique system. We quantify the ecological engineering role of the Sociable Weaver and determine the potential role of Sociable Weaver nests in a warming and increasingly arid Kalahari. The outputs of this project also contribute to eco-tourism information to enhance the experience of visitors to landscapes within the distribution of the Sociable Weaver.

Sociable Weavers returning to roost at their colony during a Kalahari sunset (Photo: Anthony Lowney).

Key co-supporters

DSI-NRF CoE grant; Tswalu Foundation; Suzuki South Africa.

Research team 2023

A/Prof. Robert Thomson (FIAO, UCT)
Dr Anthony Lowney (U Hartpury, FIAO Research Associate)
Prof. Michael Cramer (Biological Sciences, UCT)
KEEP team (led by Prof. Andrea Fuller and Prof Graham Alexander, both WITS)

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

Why do Afrotropical birds breed when they do?

Breeding seasons are considered the most important period of the annual cycle of birds, but we still lack a full understanding of why birds breed when they do. Answering this long-standing question in life history research is crucial to understanding how climate change will impact bird populations, and how those effects can be mitigated.

Our current understanding of life-history evolution and phenology is heavily biased towards the north-temperate zone, where breeding seasonality is tightly correlated with temperature and photoperiod. This has led to the notion that breeding is prioritized over other annual cycle events and that food availability for nestlings is the main determinant of breeding seasonality in birds. However, in the tropical and south-temperate zones, the link between breeding phenology and food abundance is less clear-cut. Moreover, the determinants of environmental productivity cycles may differ among tropical environments. Here, we might expect other patterns of environmental variability to be more important for the timing of birds' annual cycles. This is because where annual reproductive output is low or unpredictable, birds should prioritise investing in processes promoting self-maintenance and survival (such as moult and immunity) rather than necessarily timing breeding to coincide with periods of peak food abundance for nestlings and juveniles. This alternative hypothesis remains untested to explain both the adaptive fine-tuning of timing of breeding according to environmental conditions within species, and the striking and unexplained differences among species.

Furthermore, rainfall is considered the key determinant of food availability in seasonally arid tropical environments, but it remains unclear how a single wet season influences food availability across the year for different breeding communities.

In 2021 we started a research project to address these knowledge gaps in Choma, Zambia. Choma is a seasonally arid environment with distinct wet and dry seasons and a species-rich bird community including species breeding within or across seasons. By combining year-round field sampling of invertebrates and grass seeds with analyses of long-term bird breeding data from the work of Major John Colebrook-Robjent from 1970–2008, we have identified peak periods of specific food availability and peak breeding periods of different species. Two clear breeding peaks occur in Choma – shortly before, and after the onset of the rains, creating three breeding clusters within the bird assemblage. We are currently conducting a trait-based analyses to identify the specific traits that link each species to a cluster and determine whether this pattern is generalisable across bird communities. Thanks to CB MSc student Matt Lobenhofer and our resident colleagues in Choma who maintained our year-round invertebrate sampling, we now know that invertebrate abundance also peaks before the onset of the rains rather than after. Although, multiple smaller peaks occur after the rains.

In 2023, MSc student Yinka Abayomi combined these long-term bird breeding datasets with more recent data collected by colleagues in the Fitz (see https://www.african_cuckoos.com/) for a select group of species identified from our previous multispecies analyses to test how environmental conditions before the rains such as leaf flush, and after the rains, such as increased grass seed availability, influence the timing of breeding in different breeding communities.

In collaboration with Dr Felicity Newell (U.Bern and U.Florida), and working in the cloud forest of northern Peru, we are pooling together year-round invertebrate sampling data from different tropical environments to identify the key determinants of invertebrate abundance cycles among tropical environments. Insights from these analyses will allow us to understand whether the timing of breeding in birds is determined by the main environmental driver of seasonal invertebrate abundance rather rainfall seasonality.

We are also analysing data from immune assays from samples collected in Choma, Zambia and Jos, Nigeria to test how the immune function of birds varies across seasonal transitions from wet to dry season and vice versa. This will allow us to unravel the environmental components of rain-driven seasonal transitions that influence immune function and how factors other than the onset of the wet season or food availability, influence breeding decisions.

These projects provide an exciting opportunity to disentangle components of seasonal environmental conditions that drive avian timing of breeding in the Afrotropical ecosystem. Achieving this fundamental objective will help us detect and predict early warning signs of rapidly changing environmental conditions in Africa and other understudied biodiverse environments.

Activities in 2023

- Unfortunately, Chima is still unable to return to Cape Town due to delays in issuing an appeal decision on his Critical Skills visa application and further delays in submitting his Research Visitor's visa application, but he has continued to work remotely, conducting fieldwork in Choma and visiting collaborators in other institutions.
- Chima spent six months as a Schifferli Fellow working at the Swiss Ornithology Institute in Sempach, Switzerland. He continued working on the Choma egg collection data, while collaborating with Prof. Barbara Helm on a tri-trophic phenology project, investigating differences in the timing of breeding, moult, insect abundance and plant fruiting along a latitudinal gradient.
- Chima spent three months in the Netherlands visiting Prof. Irene Tieleman at the University of Groningen. He analysed immune function data from Choma, Zambia and Jos, Nigeria to test how the immune function of nestling and adult birds vary across seasonal transitions from wet to dry season and vice versa.
- Matt Lobenhofer successfully completed his CB MSc project assessing the association between invertebrate abundance and bird breeding seasonality using our year-round invertebrate sampling data and long-term bird breeding data from Major John Colebrook-Robjent's egg collection records.
- Matt returned to Cape Town in Nov 2023 to train Yinka Abayomi on insect identification and to complete the processing of the remaining invertebrate collection for Yinka's MSc thesis.
- MSc student, Yinka Abayomi is investigating determinants of pre-rain green-up and its association with insect abundance and bird breeding seasonality in the Afrotropics.
- UCT and Groningen Nuffic-NRF joint PhD student, Rebecca Muller continued to work on over 100,000 nest record cards held in the Niven Library assessing the impact of climate change on breeding seasonality in Afrotropical birds. Rebecca spent three months working with Professor Irene Tieleman in Groningen.

Chima at work in Zambia, scoring the moult of a Common Bulbul (Photo: Claire Spottiswoode).

Highlights

- Chima's Junior Research Fellowship was extended for two years pending a successful visa application; we are grateful to the Carnegie Developing Emerging Academic Leaders Programme for their continuing support.
- Claire Spottiswoode secured support for the establishment of the Max Planck centre at the Fitz which will provide research funding and additional two years of funding for Chima beyond the Carnegie Developing Emerging Academic Leaders Programme Junior Research Fellowship.
- Chima gave a keynote oral presentation at the 14th European Ornithologists Union Congress in Lund, Sweden.

Key co-supporters

Carnegie Developing Emerging Academic Leaders Programme; DSI-NRF CoE grant; British Ecological Society; British Ornithological Union.

Research team 2023

Dr Chima Nwaogu (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT/U. Cambridge)
Dr Gabriel Jamie (U. Cambridge/FIAO, UCT)
Dr Susan Cunningham (FIAO, UCT)
A/Prof. Arjun Amar (FIAO, UCT)
Prof. Irene Tieleman (U. Groningen)
Prof. Barbara Helm (Swiss Ornithological Institute)

Students: Rebecca Muller (PhD, UCT), Yinka Abayomi (MSc, UCT), Matt Lobenhofer (CB MSc, UCT).

Moult and migration

Together with breeding, moult and migration are the greatest challenges in a bird's annual cycle. Moulting birds suffer increased metabolic costs as well as impaired flight ability, insulation and camouflage/signalling. Birds vary greatly in how they manage these costs through changing the timing and intensity of moult, both within and between species. Globally, migrant birds are at greater risk of extinction globally than resident species due to the risks they face travelling across an increasingly transformed planet, and the need to have secure breeding and non-breeding areas. Understanding the strategies birds use to moult and migrate is crucial for their conservation.

Once formed, feathers are dead structures that start to degrade through mechanical abrasion, damage by UV light, and attack by ectoparasites, fungi and bacteria. Most feathers need to be replaced every year or so through a regular process of moult. The costs of moult are significant, so most birds schedule their moult to periods when they are not breeding or migrating (although there are numerous exceptions). New feathers grow from a ring of cells in the feather follicle, which limits their rate of growth to around 4-6 mm per day. Feathers that grow faster tend to be of poorer quality, providing less insulation and wearing faster than feathers grown more slowly. This largely invariant growth rate means that large birds take longer to replace a given feather than small birds, and so typically have more complex moult strategies than small birds, either greatly increasing the intensity of moult (e.g. replacing all flight feathers at once and becoming flightless for a few weeks while they grow new feathers) or staggering their moult over several years. The timing, intensity and symmetry of moult likely reflect individual health. And unlike breeding, moult is something that all birds must undergo. Thus monitoring how different birds moult, and how this changes over time, might be a way to track population health.

Migration is better studied than moult, but there is still much to learn regarding movement patterns among African birds. And given the less marked seasonality in the Southern Hemisphere, more species move in response to rainfall rather than temperature, especially in more arid areas. Our understanding of these nomadic movements is still in its infancy. Finally, we also contribute to an understanding of global shorebird movements through coastal bird surveys.

Cliff Dorse, Albert McLean and James Hogg counting shorebirds in the large, mangrove-lined bays south of the Save River in Mozambique (Photo: Peter Ryan).

Activities in 2023

- MSc student Taylyn Risi completed her dissertation on wing moult in oystercatchers, based on data from both traditional studies of birds in the hand and photographs of birds in flight.
- PhD student Rachel Dobson (Leeds) made good progress on a manuscript exploring the environmental triggers for Ludwig's Bustard *Neotis ludwigii* movements based on Jessica Shaw's tracking data, which has up to 11 years of data for some individuals. Some bustards undertake more or less regular migrations between the Nama and Succulent Karoo each year, following seasonal rains, whereas others are more sedentary.
- BSc Hons student Rebecca Irons completed her mini-thesis by exploring the primary feather

Checking for primary moult in a Malachite Sunbird for Rebecca Irons' BSc Hons project (Photo: Alan Lee).

moult of sunbirds and sugarbirds in South Africa using generalised additive models (GAMs) to visualise patterns.

- Peter Ryan led a synoptic survey of coastal birds in the Greater Bazaruto IBA/KBA in November 2023, in collaboration with African Parks (Evan Trotzuk) and the Vilanculos Coastal Wildlife Sanctuary (Christine Read and Dave Gilroy). The survey covered all five islands in the Bazaruto Archipelago National Park, the San Sebastian Peninsula, and the mangrove embayments north of the Save River Delta. More than 55 000 coastal birds were counted, of which 60% were shorebirds (mainly Charadriidae and Scolopacidae), 25% terns and gulls (Laridae), and 10% flamingos (Phoenicopteridae). Non-breeding migrants dominated among both shorebirds (95%) and terns (94%).

Highlights

- Taylyn Risi was awarded her MSc with distinction for her dissertation on the moult of oystercatchers.
- Three papers were published in a special issue of *Ostrich* on moult edited by Adrian Craig and Birgit Erni: on moult in the African Oystercatcher *Haematopus moquini* by Les Underhill and Taylyn Risi, on moult in the White-capped Albatross *Thalassarche* [*cauta*] *steadi* by Peter Ryan and Oluwadunsin Adekola, and on visualising moult data using GAMs by Rebecca Irons, Alan Lee, Robert Thomson and Birgit Erni.

Key co-supporters

DSI-NRF CoE grant; BirdLife International; Mohamed bin Zayed Species Conservation Fund; African Parks

Research team 2023

Emer. Prof. Peter Ryan (FIAO, UCT)
A/Prof. Robert Thomson (FIAO, UCT)
Dr Gary Allport (BirdLife International)
Dr Alan Lee (BirdLife SA)
Dr Birgit Erni (SEEC, UCT)
Dr Samuel Temidayo Osinubi (FIAO, UCT)
Dr Jessica Shaw (NatureScot)
Prof. Les Underhill (BioSci, UCT)

Students: Rachel Dobson (visiting PhD student, Leeds); Taylyn Risi (MSc, UCT); Rebecca Irons (BSc Hons, UCT).

Threats, demography and mating systems of resident plovers

Disturbances related to changing environmental conditions, presence of predators and human activities are negatively impacting the reproduction of resident shorebirds globally. Evaluating the mechanisms by which these disturbances influence breeding shorebird populations will allow informed decisions to better conserve these species and their habitats. Plovers also serve as model systems to understand avian demography, behaviour, and mating systems. In South Africa, resident shorebirds have been understudied, which is surprising given the wealth of research groups working on this group in other parts of the world. This project joins global projects focusing on shorebirds to collect breeding and demography data for individually-marked populations of these species.

The project studies a common species, the Kittlitz's Plover *Charadrius pecuarius,* and a species considered 'near threatened', the Chestnut-banded Plover *C. pallidus.* Data collection is focused on finding all breeding attempts at the study site annually and maintaining a marked population to track aspects of breeding biology, nest success and demography. When nests are successful, parental care and brood behaviour is documented with the goal of building a detailed understanding of the mating systems of these species, and how local conditions may shape strategies in comparison to populations elsewhere.

The study site is at the Berg River estuary and the commercial salt pans near the town of Velddrif in the Western Cape. It is recognised as an Important Bird and Biodiversity Area (IBA) with its high number of breeding and wintering waterbird species. The project was piloted in 2019, with the first field season initiated in 2020 and the fourth breeding season monitored in 2023.

Activities in 2023

- Robert Thomson and Anaïs Paturle led the 2023 field season between August and November. A new record season total of 129 nesting events were documented, including 57 Kittlitz's (KiP) and 51 Chestnut-banded plover (CbP) nests, with an additional 10 KiP and 11 CbP nesting events founds as broods. Nest survival was good

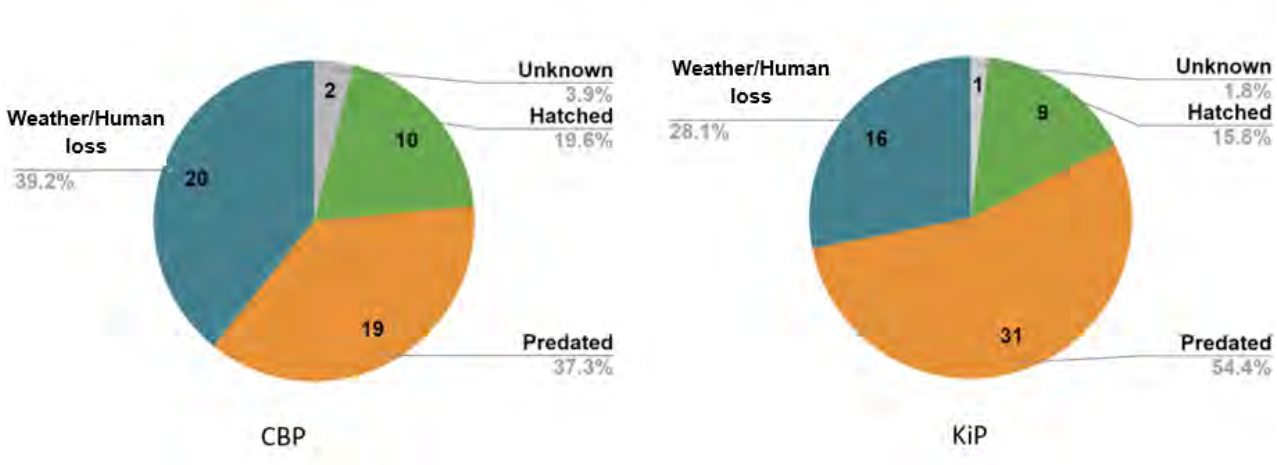


Figure 3: Fates of Chestnut-banded plover (CBP, n=51) and Kittlitz's plover (KiP, n=57) nests during the 2023 field season near Velddrif.

Both Kittlitiz's and Chestnut-banded Plovers have nests on or right next to the roads at the salt pan sites near the Berg River estuary. The result is significant disturbance and occasional trampling by clumsy birdwatchers (Photos: Anaïs Paturle).

in 2023 with about 16% of KiP nests and about 20% of CbP nests hatching (excluding those found as broods). Nest predation was a main cause of failure, along with weather events and human related trampling.

Highlights:

- Population marking led to 130 new individuals being ringed, 60 KiP and 70 CbP, with many resightings of individuals ringed in the population between 2020–2022.

Record shot of Chestnut-banded Plover 'K25' resighted near Velddrif (Photo: Elza Ferreira).

Impact of the project

This study will inform conservation efforts as it occurs at a designated IBA primarily holding important populations of waders and other waterbirds. It will further aid understanding of the threats to these species to protect them from current and future threats. In terms of evolutionary ecology, this project will provide information on the breeding and demography of these shorebird populations and will evaluate the mating system variation in the population at this site to determine whether it is linked to sex ratios, demography or other environmental/life history factors.

Key co-supporters

University of Bath; Élvonal Shorebird Science network at University of Debrecen, Kuifkopvisvanger accommodation

Research team 2023

A/Prof. Robert Thomson (FIAO, UCT)
Prof. Tamás Székely (Univ. Bath and Univ. Debrecen)
Dr Naerhulan Halimubieke (Univ. College London)
Dr Anthony Lowney (U. Hartpury, FIAO Research Associate)
Melisa Bal (KAB Ecology)
Anaïs Paturle (U. Groningen)
Dr Carina Nebel (U. Turku)

Evolution in island birds and the 'insularity syndrome'

Islands are important centres of endemism and key natural laboratories for the study of ecology and evolution. They are also hotspots of human-driven extinctions. In this research programme we investigate how island communities are assembled (island biogeography), how new species arise (speciation), and how populations adapt to the island environment. Our research uses birds from the Gulf of Guinea, Cape Verde and Tristan islands as study systems.

Gulf of Guinea – what can the land-bridge island of Bioko teach us?

MacArthur and Wilson's Theory of Island Biogeography provided a theoretical framework to explain how island communities are assembled. It is particularly applicable to oceanic islands, with its predictions recently validated with empirical data from a worldwide analysis of birds, to which we contributed (Valente *et al*. 2020, *Nature*). Land-bridge islands, which have been connected to a mainland in the past, are quite distinct. In contrast to oceanic islands, land-bridge islands are formed with a complete biota – from which species can go extinct after isolation, and others may be added by migration or speciation *in situ*. In a study led by Luis Valente and Martim Melo in 2023, we used Bioko Island (Gulf of Guinea) to investigate how parameters of the Theory of Island Biogeography play out in such setting. Our results will have implications for understanding an increasingly fragmented world and in managing protected areas – which are more similar to land-bridge islands than to oceanic ones.

Gulf of Guinea – oceanic islands: Adding the birds of Príncipe, São Tomé and Annobón to the Barcode of Life

Laboratory work was completed in 2023, so that the whole endemic bird community of the oceanic islands of the Gulf of Guinea (Príncipe, São Tomé, Annobón) is now represented in the library of the International Barcode of Life.

The island syndrome

Organisms on islands often exhibit convergent evolution on a wide suite of traits, which are together termed the "island syndrome". These common evolutionary outcomes are linked to the isolation, small size and stable climate associated with oceanic islands. Isolation reduces species richness on islands relative to mainland areas, limiting inter-specific competition and allowing for ecological release. Low species richness also results in fewer predators and parasites. During the last decade, our team has systematically investigated multiple aspects of the island syndrome, exploring a diverse array of traits (e.g. size, color, song, life-history) and looking at the role of different potential explanatory factors (e.g. competition, parasites, immune system).

Parasites on islands

Reduced parasite levels on islands could underlie the evolution of weaker immune systems, as suggested by the extinction of many Hawaiian birds after the introduction of an avian malaria vector. Since 2015, we have been documenting how humans impact the 'parasite landscape' of São Tomé Island, in a project led by Claire Loiseau, from the University of Montpellier (France). Collaborators Mathilde Barthe and Benoit Nabholz, also from Montpellier, used a large-scale genomic approach to measure the diversity of hundreds of immune response genes from our Gulf of Guinea dataset. The results show that both genetic drift and relaxed selection lead to a decrease in immune function among island birds. This confirms our worries, as human-driven habitat change is likely to alter vector-parasite-host dynamics, together with increasing the likelihood of introducing new hosts and parasites to islands.

Príncipe Island – more news on the Príncipe Scops-Owl

After the description of the Principe Scops-Owl *Otus bikegila* in late 2022, the team led by Martim Melo published a paper on the distribution, habitat associations, and population estimates of this Príncipe Island endemic. Based on these data, the article recommended the species be listed as

São Tomé's mystery Storm-petrel. Since 1996, Rita Covas, Martim Melo and collaborators have been trying to identify the species of the Band-rumped Storm Petrel that are regularly seen offshore the islands of São Tomé and Príncipe, Gulf of Guinea. It is now known that they nest in the rainforests of São Tomé's interior but, so far, no nests have been found. In 2023, Robert Flood put together a team to try to unravel this mystery. Many individuals were observed and photographed at sea (left), and six were captured on land - attracted by factory lights on foggy nights. Of these six, two died and were collected. Kristof Zyskowski (below), a collaborator from the Yale Peabody museum which contains one of the largest collections of this group, came to Portugal to prepare the specimens (centre: drying after preparation) (Photos: Kirk Zufelt (at sea), Callan Cohen (measuring), Martim Melo (specimen preparation).

Art meets Science in São Tomé's forests. The team studying the endemic birds of São Tomé Island – and their parasites – was joined by a group of artists (left), including a choreographer who produced the video-performance "Or l'Oiseau" out of this experience (right).

Critically Endangered – an evaluation that was taken up by BirdLife International/IUCN in the December 2023 update of the IUCN Red List of Threatened Species. In parallel with this, the team published a paper detailing an automatic monitoring protocol for the species, based on the deployment of automatic recording units (Audiomoths) along transects in the area of occurrence, together with automatic retrieval of the owl calls. This will make feasible long-term monitoring of this nocturnal species across its small (~30 km^2) but difficult to access range.

São Tomé - in search of yet another mysterious bird

After the discovery and description of the new species of scops-owl on the island of Príncipe, one could think that the islands of São Tomé and Príncipe, in the Gulf of Guinea, no longer hold any secrets when it comes to birds. The truth is that Martim Melo has been trying to unravel the mystery of another bird: the São Tomé Band-rumped Storm-Petrel *Hydrobates* cf. *castro*, since he first visited the islands in 1996, as part of a team led by Rita Covas and the late Luis Monteiro.

In 1928, Portuguese collectors José and Virgínia Correia, working for the American Museum of Natural History (AMNH), obtained four specimens of a storm-petrel that, on a foggy night, crashed into a property, attracted by the light. These specimens at the AMNH were similar to *Hydrobates castro*, but larger. Within storm-petrels it is common for distinct species to be morphologically similar. In 1996 and 1997, all the islets and rocks were visited to look for nesting sites, but without success. It was then hypothesised that the species nested within the dense rainforests of the island's interior - a habitat where it is almost impossible to find nests. Later, during the long-term research on the endemic birds of these forests, the presence of storm-petrels was confirmed by vocalisations that could be heard at night during several months of the year. Although no nests have yet been found, it is now certain that they do indeed nest in the forest.

In 2023, a new team was put together by Fitz Research Associate Robert Flood to try to solve this mystery. The main objective is to determine which species of storm-petrel nests on São Tomé, the alternatives being: a population of *Hydrobates castro*, a population of the Cape Verdean species *H. jabejabe*, or a new species.

In June 2023, Robert Flood and Martim Melo joined a team of eight with the aim of gathering as much information about the species as possible and trying to capture individuals to obtain essential blood samples for genetic analyses. There were night-time surveys in exposed areas of the coast close to the forest, four pelagic trips, and camps set up inside the forest to try and locate nests. The pelagic trips (c. 12 kilometres offshore) proved to be the most fruitful, allowing dozens of individuals to be observed and photographed. The birds were lured with oil and fish guts and a large handheld net was used to try and catch them - which was not successful. Martim Melo did, however, manage to capture a Wilson's Storm-petrel *Oceanites oceanicus*, which led to an unexpected discovery: the individual captured (along with others photographed) appears to belong to the subspecies *chilensis* - which nests in the Cape Horn region - and not the nominal

subspecies as previously thought. A feather sample was taken to confirm this hypothesis. In July and August, local collaborator Martim Veiga was able to measure and obtain samples from four individuals obtained in the same way as José and Virgínia Correia: individuals that are attracted to lights on foggy nights, in this case at the Agripalma palm oil factory. In September, Martim Melo returned to São Tomé where he went out to sea and obtained more samples and measurements from two individuals who were also attracted by the lights from the Agripalma factory. In a short space of time, Martim was able to obtain measurements and samples from six individuals, which will contribute to solving the mystery. Of the six individuals attracted by the lights, two died and four were released. Kristof Zyskowski, head of vertebrate collections at the Yale Peabody Museum, travelled to Portugal to prepare the skins of two dead specimens.

Cape Verde Islands

The Iago Sparrow *Passer iagoensis*, endemic to the Cape Verde archipelago, makes an excellent model for the study of adaptation in the wild. It occurs across a wide aridity gradient on 13 islands and islets, allowing insights into how birds may adapt to an increasingly arid world. It is also a good model to study the evolution of commensalism, as humans only colonised the archipelago 500 years ago, and some islands remain uninhabited. Fitz Research Associates Martim Melo and Rauri Bowie are collaborating with Ângela Ribeiro, Mark Ravinet and José Cerca on a project that combines fieldwork and genomics to untangle the Iago Sparrow's recent micro-evolutionary history.

Activities in 2023

- Laboratory work to obtain barcodes for all endemic birds of the oceanic islands of the Gulf of Guinea was completed.
- Work on the Art and Science project associated with ongoing research on São Tomé progressed well. A 25-min video-performance (Or l'Oiseau) was produced with English, French and Portuguese versions) short documentary-outreach videos were finalised, and funds were obtained to create an exhibition that will travel between France, Portugal, and São Tomé.
- The search for the mystery São Tomé Storm-petrel was relaunched.

Highlights

- The first genetic samples were obtained for the Band-rumped Storm Petrel from São Tomé, together with a wealth of photographs to build our understanding of this mystery taxon.
- Two papers were published in international journals:
  - Ponti, R., Doutrelant, C. and Covas, R. 2023. Strength of the 'island rule' in birds is positively associated with absence of avian predators. *Biology Letters* 19: 2022053620220536.
  - Melo, M., Covas, R., et al. 2023. DNA Barcode library of the endemic-rich avifauna of the oceanic islands of the Gulf of Guinea. *Biodiversity Data Journal* 11: e110428.

Impact of the project

This project is uncovering novel patterns of adaptation in island birds and investigating the mechanisms underlying these adaptations. The findings contribute to our understanding of the ecology and evolution of island environments. Given the large number of species endemic to islands worldwide and the numerous threats they face, our work will inform conservation strategies for island species. The ongoing 'art & science' project will have a variety of outputs that will improve public outreach.

Key co-supporters

FCT - Portuguese Science and Technology Foundation; CNRS-France (PEPS); Marie Sklodowska-Curie Grants.

Research team 2023

Dr Martim Melo (FIAO, UCT/CIBIO, U. Porto)
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Dr Mark Ravinet (U. Oslo)
Dr José Cerca (U. Oslo)
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Dr Luis Valente (Naturalis Biodiversity Center, Leiden)
Dr Ricardo Lima (cE3c, U. Lisbon)
Prof. Bengt Hansson (Lund U.)
Emer. Prof. Peter Ryan (FIAO, UCT)
Dr Raquel Ponti (CIBIO, U. Porto)
Dr Ana Leitão (CIBIO, U. Porto)
Prof. Rauri Bowie (U. California Berkeley)

Impacts of power infrastructure

This project mitigates the impacts of power generation and transmission infrastructure on birds and other biota. The projects focus on both collision impacts associated with powerlines, which mainly affect large, open-country birds such as bustards and cranes and 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 collaboration with BirdLife South Africa's Birds and Renewable Energy programme, the Endangered Wildlife Trust (EWT) and HawkWatch International (HWI).

Activities in 2023

- PhD student Christie Craig, based at the EWT, completed her thesis on the viability of Blue Crane *Anthropoides paradisea* populations in the Western Cape and Karoo. Powerline collisions are one of the main threats to Blue Cranes, and assessing the severity of this threat formed the basis of one of the chapters of her thesis. She found that proximity to seasonal wetlands was a useful predictor of collision risk in the Western Cape, which will be useful for planning the routing of new power lines as well as mitigating collision risk by retrospective marking of existing high-risk lines. She also analysed crane movements in relation to powerlines, and showed that non-breeding cranes, which move farther than breeding birds, are at greater risk of collisions. Christie submitted her thesis for examination in February 2024.
- Robin Colyn made steady progress towards his PhD on the factors determining the distributions of range-restricted larks across an aridity gradient in southern 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.
- Sanjo Rose obtained her MSc for her study on the ecology of Agulhas Long-billed Larks *Certhilauda brevirostris*, a little-known species that has numerous wind energy developments planned in its restricted range.
- CB MSc student Michelle Bouwer completed her research project on factors influencing Blue Crane hatching success in the Overberg, which was initiated following observations of worryingly low chick production estimates arising from Christie's PhD research.
- Chris Vennum (ABAX Foundation post-doctoral fellow), together with Arjun Amar and Megan Murgatroyd explored whether turning off wind turbines during the daytime could be used as a mitigation method to reduce the impact of wind energy facilities where these pose a high risk to Verreaux's Eagles. This work investigated levels

Megan Murgatroyd (and team!) continued in 2023, with their work to trap Black Harriers. This endemic and declining species is very vulnerable to additional mortality caused by wind turbines, and our aim is to better understand their movements during the breeding season to reduce these impacts (Photo: Jessie Walton).

Merlyn Nkomo continued her PhD research to trap and fit GPS tags to Jackal Buzzards, with the help of ABAX post-doc Dr Chris Vennum. Jackal Buzzards are the most frequently killed species at wind energy facilities in South Africa and Merlyn's research aims to help better plan wind energy facilities to reduce the risks of collision with this species (Photo: Chris Vennum).

of nighttime flights by this species using GPS tracking data.

- Our research collaboration with HWI on tracking Black Harriers *Circus maurus* continued to progress, with Megan Murgatroyd and Sanjo Rose managing to deploy tags on seven harriers in 2023. These data will be used to build a risk model to help reduce the impact of wind farms on breeding Black Harriers.
- Merlyn Nkomo continued her PhD on the interaction between Jackal Buzzards *Buteo rufofuscus* and wind farms. Merlyn is supervised by Arjun Amar and Meg Murgatroyd with help in the field from Chris Vennum. In 2023, Merlyn deployed a further 2 transmitters onto Jackal Buzzards in the Western Cape. We now have 11 active trackers on this species. Merlyn completed her interviews with stakeholders within the wind energy sector to better understand their research priorities and needs for Jackal Buzzards, and a paper documenting this has been submitted.

Highlights:

- MSc students Sanjo Rose and Michelle Bouwer both graduated in 2023.
- Sanjo Rose's paper on the breeding biology of the Agulhas Long-billed Lark was published in the *Journal of Ornithology*.
- Francisco Cervantes, Arjun Amar, Megan Murgatroyd and collaborators published their paper on the predicted space use of Cape Vultures across their entire global range in the journal *Ecological Applications*. Additionally, the team worked with the Department for Fisheries, Forestry and the Environment (DFFE) to develop a categorical risk map which was used in the Gazetted protocol for wind energy facilities and vultures.
- Arjun Amar, Megan Murgatroyd, and Merlyn Nkomo attended the Bird & Renewable Energy Forum, where they presented work on wind farm risk models for Verreaux's and Martial Eagles, and on the co-production of research priorities for Jackal Buzzards.

Key co-supporters

Endangered Wildlife Trust – Eskom Strategic Partnership; The Bateleurs; BirdLife South Africa; BTE Renewables; Hans Hoheisen Charitable Trust; Leiden Conservation Fund; Dave Myers; ABAX Foundationn; The Shannon Elizabeth Foundation.

Research team 2023

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A/Prof. Susie Cunningham (FIAO, UCT)
Dr Chris Vennum (FIAO, UCT)
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Dr Megan Murgatroyd (HawkWatch International, FIAO, UCT)
Dr Francisco Cervantes (SEEC, UCT)

Students: Robin Colyn (PhD, UCT); Christie Craig (PhD, UCT); Merlyn Nkomo (PhD, UCT); Sanjo Rose (MSc, UCT), Michelle Bouwer (CB MSc, UCT).

Conserving Martial Eagles

This project is aimed at better understanding the ecology and conservation of Martial Eagles *Polemaetus bellicosus*, with a particular focus on the declines observed within the country's largest protected area, the Kruger National Park. This research is important to understand the role of protected areas for conserving wide-ranging species and to understand specific threats and habitat requirements for the conservation of Martial Eagles.

This project was initiated in response to the decrease in reporting rates of Martial Eagles between the Southern African Bird Atlas Project, SABAP1 (1987-1992) and SABAP2 (2007-ongoing), which suggests a population decrease of up to 65% across South Africa. Declines were also observed inside large protected areas, such as the Kruger National Park (KNP), which experienced a 54% decrease in reporting rate. Similar decreases have been reported elsewhere in Africa resulting in the species being uplisted to 'Endangered' on the IUCN Red List.

We aim to improve our understanding of the threats faced by Martial Eagles and how these threats may drive population decreases even within protected areas. 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 widely. Contrary to this hypothesis, we found little evidence for low survival during these early life stages, despite immature eagles ranging far beyond protected area boundaries. However, results from GPS tracking of adult birds and nest monitoring suggested two potential factors that may contribute to the observed population decreases: 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 population decreases.

Nest monitoring indicates that two factors contribute to the low breeding productivity: a low proportion of pairs attempting to breed and low breeding success. However, due to the vast nature of KNP and difficulty in detecting all nests, using GPS tracking we have recently found that breeding performance may be better than initially thought. For several years we have been placing cameras at nests to better understand the factors that influence prey provisioning rates and diet.

Although we are no longer actively monitoring nests on the ground in KNP, we are continuing to follow our tracked eagles to determine the frequency and causes of mortality, as well as the breeding status of our tracked birds to gain a more comprehensive understanding of the environmental drivers of breeding performance.

Additionally, we have collaborated with the Endangered Wildlife Trust (EWT) on their project monitoring the Martial Eagles nesting on power pylons in the Karoo. This population may be the largest in South Africa, yet little is known about their productivity rates or survival, and whether this population may be acting as a source population for the rest of the region.

Activities in 2023

- Kyle Walker completed his analyses and will submit his MSc thesis in Feb 2024. Kyle's research explores how this species may respond as temperatures warm due to climate change. He investigated how provisioning rates of adults to their nestling change in hotter conditions, and whether diet flexibility may allow this species to adapt to rising temperatures. This analysis uses data from 12 camera traps that were placed at nests during the nestling period.
- We re-analysed the breeding data collected from 2013-2021, alongside the GPS tracking data. These analyses have shown that GPS tracking can improve the accuracy of breeding estimates. We also reviewed the financial and carbon costs of traditional field monitoring, versus GPS tracking projects, and found that the latter method is considerably more cost-effective.
- This new analysis based on GPS tracking suggests that the productivity of this population is higher than previously estimated through field monitoring alone. Using these revised productivity estimates, within the population models built by Rowen van Eeden, it appears

A photo from one of our remote cameras (inset image) – these cameras were placed at Martial Eagle nests in Kruger National Park. The cameras documented prey deliveries to the nestlings (here a monitor lizard). Kyle Walkers MSc thesis (funded by the ABAX Foundation) examined how prey delivery rates and the types of prey delivered were influenced by temperatures.

that the Kruger population may actually be self-sustaining.

- Jane Doherty completed her Conservation Biology mini-thesis exploring the breeding success and survival rates of Martial Eagles breeding in the Karoo. This thesis uses EWT monitoring data collected over the last three years. Jane fed breeding and survival estimates into a Population Viability Analysis to explore the sustainability of this population. Unfortunately, this population does not appear to be as sustainable as first thought, with relatively high mortality rates suggesting that this population is unlikely to be functioning as a source population.

Highlights

- Megan Murgatroyd, Arjun Amar and Gareth Tate published a paper in *Royal Society Open Science* showing the benefits of monitoring breeding productivity of Martial Eagles using tracking devices.
- Jane Doherty graduated in December 2023 with a MSc Conservation Biology. Jane presented her research findings at the EWT conference in Swadini, near Hoedspruit in November.
- Arjun Amar was a co-author on a paper, published in *Nature Ecology and Evolution*, which explored changes in raptors across African Savannas, this included the Martial Eagle which had declined by over 90% over 3 generations lengths. These findings suggest that the IUCN status of this species may need to be reconsidered for uplisting.

Impact of the project

Our research provides a better foundation for protecting this Endangered species, within the most important areas for this species in South Africa.

Key co-supporters

ABAX Foundation; Anthony Sedgewick, DSI-NRF CoE grant; Endangered Wildlife Trust (EWT); Jock's Safari Lodge; SANParks; Eskom.

Research team 2023

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Dr Gareth Tate (EWT)

Students: Kyle Walker (MSc, UCT), Jane Doherty (CB MSc, UCT).

Vulture conservation

Several vulture populations in Africa have declined by up to 95% over the last few decades. The critical nature of this rapid decrease was highlighted when parties to the Convention on Migratory Species (CMS) adopted the Multi-species Action Plan to Conserve African-Eurasian Vultures (Vulture MsAP). Unlike the Asian Vulture Crisis, where the veterinary drug diclofenac was responsible for the collapse, there appear to be multiple drivers of the African Vulture Crisis, with the importance of each varying between species and regions.

Vultures provide important ecosystem services, and their rapid declines will have a dramatic effect on people and wildlife in Africa. The FitzPatrick Institute is committed to help conserve vultures by engaging in collaborative research projects throughout the continent.

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 globally Endangered or Critically Endangered. Central to this research is an attempt to quantify changes in vulture populations in Botswana over the last 30 years by repeating road transects undertaken in the early 1990s, as well as to repeat aerial surveys of key colonies.

We are also a key partner in the conservation of the Bearded Vulture *Gypaetus barbatus* in southern Africa. We have a long-standing collaboration with the team from Ezemvelo KZN Wildlife, where several students have worked on this important conservation project.

Building on our successful predictive space use model for the Bearded Vulture, we have now also completed a space use model for the Cape Vulture *Gyps coprotheres* across its entire global range. This was a large collaborative project using data from almost every organisation that has put GPS tags on this species. These predictive maps are now being used by the Department of Forestry, Fisheries and the Environment (DFFE) to help guide wind farm placements to protect this important and threatened species.

Activities in 2023

- Our published space use model for Cape Vultures was incorporated into the DFFE protocol to guide wind farm placement for vultures. This protocol was made available for consultation to be gazetted by government at the end of 2023.
- Vultures Namibia fitted five more juvenile Lappet-faced Vultures *Torgos tracheliotos* with GPS tracking units in the Namib Naukluft National Park to study early-life movements and survival in this harsh landscape.
- In collaboration with researchers at the Leibniz Institute for Zoo and Wildlife Research, Andrea Santangeli used data from 20 GPS tracked Lappet-faced Vultures from Botswana, to better understand and map the exposure of these birds to intentional and unintentional poisoning risk across Southern Africa. This work is a collaboration between Raptors Botswana, Arjun Amar and Robert Thomson. This work has been submitted to a scientific journal for publication.
- MSc student Rochelle Mphetlhe completed her thesis analysing repeated road transect data, combining her data for the south of Botswana with similar data for the Northern region undertaken by a previous Fitz PhD student, Dr Beckie Garbett. This study revealed mainly similar trends to those found in the North, but also some surprising differences. This work will be submitted for publication in early 2024.
- MSc CB student Charles Mpofu explored the diet of GPS tracked vultures across Botswana by ground truthing over 100 potential feeding sites based on the GPS 'signatures'. Charles was supervised by Arjun Amar, Gareth Tate (EWT) and Glyn Maude (Raptors Botswana).

Highlights

- Christiaan Brink was awarded the 2022 Faculty of Science Purcell Memorial Prize in March 2023. The prize is awarded annually for the best thesis in a zoological study area at UCT. Christiaan's PhD thesis was entitled "The role of supplementary feeding sites in vulture conservation in South Africa".
- Our predictive space use model for Cape Vultures, developed by Francisco Cervantes,

was published in the American Ecological Society's journal, *Ecological Applications.* We were pleased to see that the DFFE incorporated a simplified version of our risk map into their Cape Vulture Protocol for use in EIAs for onshore wind farms.

- Rochelle Mphetlhe and Charles Mpofu both graduated with their MSc in 2023. They also presented their research at the EWT Birds of Prey Conference, and are currently writing up their theses for publication.
- Andrea Santangeli and colleagues published a paper in *Biological Conservation* based on a spatial planning study to identify areas of conflicts and synergies for wind energy development and bird conservation in Finland.
- Andrea Santangeli presented the results of a pan-European vulture survival project named SURVIVALIST at the European Vulture Conference, which was organised by the Vulture Conservation and held in Caceres (Spain). The results presented highlight high survival rates across three of the four European vulture species, which align with the good status of their populations across the continent.
- Tevin Adams completed fieldwork for his CB MSc thesis. Tevin used GPS tracking data to better understand the space use of juvenile Cape Vulture *Gyps coprotheres* from the Potberg colony, which is situated in an area where numerous wind energy developments are either operational or planned. His fieldworkinvolved visiting potential feeding sites (identified through GPS tracking analysis by Gareth Tate of EWT) and identifying what the vultures were feeding on. Tevin will submit his thesis in February 2024.

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 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.

Conservation Biology MSc student Tevin Adams searching for an animal carcass following identification of a potential feeding site by GPS tagged Cape Vultures from the Potberg colony (Photo: Chris Swart).

Key co-supporters

NRF Innovation Scholarship; ABAX Foundation; BTE Renewables; JW Jagger Grant; Denver Zoo; Raptors Botswana; Rufford Grant; Wilderness Wildlife Trust; Colombus Zoo; Leslie Brown Memorial Grant; Peregrine Fund; IDEA Wild; Ezemvelo KZN Wildlife; Endangered Wildlife Trust; N3TC through Wildlands; Vultures Namibia; VulPro; HawkWatch International; University of Marburg; Academy of Finland; WildBird Trust.

Research team 2023

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Dr Glyn Maude (Raptors Botswana)
Dr Richard Reading (Raptors Botswana)
Dr Moses Selebatso (Raptors Botswana)
Dr Gareth Tate (Endangered Wildlife Trust)
Dr Beckie Garbett (BirdLife International)
Kai Collins (WildBird Trust)

Students: Rochelle Mphetlhe (MSc, UCT), Charles Mpofu (CB MSc, UCT), Tevin Adams (CB MSc, UCT).

Southern Ground-Hornbill conservation

Southern Ground-Hornbills *Bucorvus leadbeateri* are large, group-living birds that require extensive territories with large trees for breeding and roosting. Habitat loss has led to a two-thirds reduction in their range in South Africa during the past century. A long-term study has investigated their habitat use, breeding success, and dispersal. Now we are studying how group members contribute to territory defence and reproduction, and whether larger groups are more resilient to environmental change. We are also investigating how high temperatures influence breeding success and nestling growth rates.

The long-term project has provided nest boxes to 24 ground-hornbill groups in the Associated Private Nature Reserves (APNR), adjacent to Kruger Park. Together, these groups make 12-15 breeding attempts each year. This area is now a national population stronghold for the species and this successful population is now dispersing outside of the APNR and is re-populating the surrounding area. The project also provides second-hatched chicks (which invariably die of starvation in the wild) to the Mabula Ground-Hornbill Project (MGHP) for captive-rearing and later release. PhD student Kyle-Mark Middleton, supervised by Rita Covas, Claire Spottiswoode and Fanny Rybak, studied the hornbill's social structure and individual contributions to breeding and territory defence. He compared different groups' dawn choruses and used play-back experiments to determine if the birds recognise different groups. He also used camera traps at the nests to obtain insights into the hornbills' private lives, and analysed long-term data to investigate the environmental and social factors affecting breeding performance.

PhD student Carrie Hickman, supervised by Rita Covas and Susan Cunningham, continued her work investigating whether high air and nest temperatures impact hornbill nestlings by measuring nestling growth, fledging size and telomere length (a measure of physiological condition). She is also recording the hornbill's behavioural responses to high temperatures. iButtons (devices used for data logging) have been installed inside nests to obtain hourly temperature recordings and camera traps are used to record provisioning. The results from these analyses will assist in designing better nest boxes for the species and provide information on locations where the birds will have the best chance to persist, where microsites are more favourable and temperature increases are slower.

Taking final nestling measurements before fledging (Photo: Chad Cocking).

Activities in 2023

- Kyle-Mark Middleton graduated in March 2023 with his thesis "Individual contributions to group behaviour in the cooperatively breeding southern ground-hornbill".
- Kyle now works for Mabula Ground-Hornbill Project as senior coordinator implementing conservation actions throughout the lowveld, but he remains as an important part of the ground-hornbill team and assists with field work.
- Carrie Hickman successfully carried out another field season for her PhD, where nine ground-hornbill nestlings fledged in February and March 2023, contributing to her dataset on nestling growth and physiology.
- Carrie completed a winter field survey in July, looking at shade availability for ground-hornbills. Towards the end of the year, she continued with fieldwork for another breeding season which included weighing and measuring nestlings at specific ages to obtain growth rates.
- Kyle and Carrie attended and presented at the 8th International Hornbill Conference in Bangkok, Thailand. They visited Khao Sok National Park, where they were lucky to see the Great Hornbill and Oriental Pied Hornbill as well as many other incredible bird species.

- In August, Carrie travelled to Cape Town to attend and present at both the Fitz AGM and the Hot Birds Research Project biennial conference.
- Kyle continued to assist on the project, helping with ongoing repairs and replacement of artificial nest boxes. This ensures that ground-hornbills can continue to thrive in the study area, which has few natural nest cavities.
- In October, Carrie and Kyle participated in an episode of the podcast, "Campfire Conversations" with Brett Horley of BHS Safari Company where they discussed their work conserving and researching ground-hornbills.
- In December, five second-hatched chicks were removed from nests in the APNR and transported to the MGHP's rearing facility at Loskop Dam. This year a volunteer pilot from the Bateleurs (an environmental airforce who fly for conservation projects), flew three of these chicks to the facility. This decreased the transport time to just one hour compared to 5 hours, reducing the stress on both the tiny chicks and team involved in the process.
- In December, Katleho, an intern from Mabula Ground-Hornbill project, and Roos, an MSc student from the Netherlands joined the project in the field to gain some fieldwork experience.

Highlights:

- Kyle graduated with his PhD in March 2023.
- The 2022/23 breeding season saw nine chicks fledge out of 15 breeding attempts and the 2023/24 breeding season started well with 14 breeding attempts.
- Five chicks were harvested for the reintroduction programme, with some flown to the rearing facility by the Bateleuers.
- Three new groups have been indentified in the APNR, thanks to camera traps placed at nests.
- An incubating female was killed inside the nest by an intruding pair of ground-hornbills. Footage of this was captured on a camera trap which then showed the remaining group members accepting the intruding pair into their group over the weeks that followed.
- Six new nests were placed outside the study site to encourage natural dispersal.
- Three new nests were installed on the edges of the reserve within the study site, where ground-hornbills have been seen, but natural nests have not been found.
- A new active natural nest was discovered within the APNR.

Impact of the project

This project continues to generate fundamental knowledge about the species, the factors affecting reproduction, their social structure and their physiology. It also contributes to the population growth of Southern Ground-Hornbills in the APNR and has demonstrated the efficacy of artificial nests as a conservation tool in areas where natural cavities are scarce. The surrounding areas are now beginning to benefit from the project, with new groups occurring in areas previously lacking ground-hornbills. The project contributes to the national Southern Ground-Hornbill Species Action Plan and the Southern Ground-Hornbill Reintroduction Plan.

A protective mother with her nestling (Photo: Kyle Middleton).

Key co-supporters

The Foundation for Science and Technology FCT, Portugal; Associated Private Nature Reserves; National Geographic Society; The Rufford Foundation; Mary Oppenheimer & Daughters Foundation; John Solomon; Timothy Hancock Charitable Trust; Wild Wonderful World; Bateleurs.

Research team 2023

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A/Prof. Susie Cunningham (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT / U. Cambridge)
Dr Fanny Rybak (U. Paris-Sud, France)
Dr Kyle-Mark Middleton (FIAO, UCT / Mabula Ground- Hornbill Project)

Student: Carrie Hickman (PhD, UCT)

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, and by invasive species on land. Monitoring seabirds provides a window into the health of the Southern Ocean.

Most fieldwork takes place through the South African National Antarctic Programme (SANAP) at the Prince Edward Islands, Tristan da Cunha, Gough Islands and Antarctica. Fitztitute seabird research on Marion Island, the larger of the two Prince Edward Islands, commenced in the 1970s. John Cooper initiated a series of seabird study colonies in the early 1980s, but servicing these long-term studies through a succession of three-year research projects has become increasingly challenging. Maëlle Connan (NMU) and Peter Ryan were awarded a research grant through the South African National Antarctic Programme for 2021-2023. The project focuses on avian scavengers at Marion Island to establish robust baselines prior to the planned mouse eradication. During 2023, monitoring at Marion and Antarctica was undertaken by collaborating with CoE partner Azwianewi Makhado from the Department of Forestry, Fisheries and the Environment (DFFE). Monitoring at Gough Island has been taken over by the RSPB.

Activities in 2023

- 2023 was the final year of data collection for the SANAP project on avian scavengers at Marion Island led by Maëlle Connan and Peter Ryan. A highlight was the high Brown Skua *Catharacta antarctica* breeding population count in 2023/24, indicating the recovery of the island's skua population.
- The long-awaited summer survey of Prince Edward Island finally took place in November 2023. Maëlle Connan, Azwianewi Makhado, Makhudu Masotla and Stefan and Janine Schoombie conducted bird surveys across the island.
- After a two-year leave of absence on Gough Island, PhD student Kim Stevens made steady progress towards her PhD on Grey-headed Albatrosses *Thalassarche chrysostoma*. She submitted her first paper, which reports the steady growth of the Marion Island population.
- Danielle Keys (PhD student at NMU) continued her research on the interaction between foraging behaviour and demographic responses in Wandering Albatrosses *Diomedea exulans*.
- Tegan Walker completed her MSc at NMU on the diet of Brown Skuas at Marion Island and the link between diet and breeding parameters.
- Theresa Burg's MSc student, Dilini Abeyrama, explored the phylogeography of *Phoebetria* albatrosses using a suite of genetic markers.
- Peter Ryan led visits to two Emperor Penguin colonies in central Dronning Maud Land, including the first visit to the Astrid colony, which was only known from satellite imagery. He also submitted a paper on the seabirds of the Schirmacher Oasis, indicating how food subsidies from research bases allowed the breeding population of South Polar Skuas *Catharacta maccormicki* to increase historically to the point that they likely caused the local extinction of Snow Petrels *Pagodroma nivea*.

Highlights:

- Susie Cunningham and Peter Ryan obtained funding from SANAP for a three-year project on the impact of climate change on seabirds breeding at Marion Island, which will commence in 2024.
- Lyle de Menezes was awarded his MSc from NMU on the trophic ecology of, and plastic loads in, petrels breeding at Marion Island.
- Six papers on Southern Ocean seabirds and their conservation were published in 2023.
- Peter Ryan inferred long-term changes in petrel populations on Inaccessible Island, Tristan da Cunha, from Brown Skua diet in a paper published in a special issue of *Ostrich* in memory of Richard Dean.

Repeating transects from the early 1980s to investigate long-term changes, Drs Maëlle Connan and Stefan Schoombie estimated the density of burrow-nesting seabirds along transects at several locations on Prince Edward Island. Here, a quadrat was being set up on a transect line going up Platkop. All burrows in the quadrats were counted and species identified by the size and shape of the burrow entrance. Where nests were active, the occupants could sometimes be confirmed by responses to playback calls, or the use of burrow-scope cameras (Photo: Stefan Schoombie).

- Stefan Schoombie reported a new method to infer seabird body angle from magnetometer data, in *Royal Society Open Science* and explored the effects of wind on fine-scale dynamic soaring behaviour of Wandering Albatrosses in *Marine Ecology Progress Series*.
- Mia Momberg (former PhD student at U Pretoria) explored the factors determining nest-site selection by Wandering Albatrosses on Marion Island, with special reference to wind fields, in a paper in *Ibis*.
- Janine Schoombie led on a paper reporting wind-induced mortality of Grey-headed Albatrosses breeding on Marion Island, published in *Marine Ecology Progress Series*.
- Stefan Schoombie and Peter Ryan contributed to a paper led by Elham Nourani in *Current Biology* that explored the importance of seabird morphology on their ability to cope with gale-force winds.
- Newi Makhado (Honorary Research Associate) has served on the Southern Ocean Observing System (SOOS) steering committee in the Southern Indian Ocean sector (SOIS) Regional Working Group from 2021 until the present. He chairs the Commission for the Conservation of Antarctic Marine Living Resources General Capacity Building fund.
- Newi led and co-chaired a workshop on the pelagic eco-regionalisation in the subantarctic Indian oceans held in France in May 2023 and presented in both the SANAP Symposium and the Working Group on Ecosystem Monitoring and Management (WG-EMM) in South Africa and India.

Key co-supporters

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

Research team 2023

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Prof. Rory Wilson (Swansea U.)

Students: Danielle Keys (PhD, NMU); Kim Stevens (PhD, UCT); Lyle de Menezes (MSc, NMU); Tegan Walker (MSc, NMU).

Field assistants: Andile Mdluli, Tebogo Peta, Lucy Smyth (Marion 2022/23); Chris Jones, Michelle Risi (Marion 2023/24).

Hot Birds – birds and climate change

The 'Hot Birds Research Project' (HBRP) is a research programme that integrates behavioural and physiological approaches to predict the impact of climate change on birds in southern Africa and globally. The HBRP's research has historically focused on birds in arid habitats in southern Africa, but also involves work in North America and Australia, and increasingly involves birds in mesic and humid environments.

On the 9th January 2024, the European Union's Copernicus Climate Commission announced that 2023 was the hottest year since records began. Temperatures were close to 1.5°C above pre-industrial averages. This correlated with a return to El Niño conditions after several La Niña years. The record temperatures in 2023 coincided with record extreme events: including the lowest minimum winter sea ice ever recorded around Antarctica, massive destructive wildfires in Canada, southern Europe and Hawaii, and devastating floods in Libya. Climate change is no longer a threat looming in the future: the impacts are here and now. In response, the HBRP is increasingly working on red-listed species that already face other threats in addition to climate change. In addition, we are stepping up research on mitigation interventions and mechanistic modelling, and continuing data collection on how behaviour and physiology inform climate change vulnerability and resilience of birds.

Temperature effects on behaviour – habitat, hydration and humidity

During 2023, MSc student Jaimie Whyte submitted her thesis on the impacts of temperature on behavioural thermoregulation, microsite use, and foraging behaviour in White-browed Sparrow-Weavers *Plocepasser mahali*. Jaimie investigated whether habitat features had the potential to mitigate impacts of hot weather on the birds. She discovered that sparrow-weavers inhabiting shadier home ranges panted less at high air temperatures than those in sunnier home ranges, and as a consequence had higher foraging efficiency. She also showed that the shadiest home ranges significantly buffered evaporative water loss rates calculated for the birds, and that habitat structure may therefore be extremely important for persistence of this and other species under ongoing climate warming.

Meanwhile, MSc student James Short completed his fieldwork on the behaviour and physiology of

A White-browed Sparrow-weaver, fitted with a temperature sensitive microchip (PIT tag), has both body mass and body temperature recorded while it visits a scale balanced atop a PIT-tag reader, as part of Shannon Conradie's post doc work validating the use of biophysical models to estimate water costs of thermoregulation in changing climate (Photo Shannon Conradie).

chats and larks in the Tankwa Karoo desert. James assessed behavioural thermoregulatory responses of Karoo Chats *Emarginata schlegelii* to extremes of heat and cold in summer and winter and investigated whether these behavioural adjustments correlated with changes in foraging. James' next steps are to map these results to long-term climate trends for the region to assess the potential effects of warmer winters and hotter summers for chat behaviour and foraging success. James' second chapter compares physiological heat tolerances of Large-billed Larks *Galerida magnirostris* from the Tankwa Karoo to those of other bird species in arid environments; and assesses the impact of drinking behaviour on thermal physiology in small birds.

During 2023, PhD student Ben Murphy also investigated the importance of water to bird behaviour under hot conditions. He completed fieldwork for a study of the relationship between hydration status and behavioural responses of Fork-tailed Drongos *Dicrurus adsimilis* to high air temperatures. Ben altered the hydration status of drongos by feeding them either mealworms injected with extra water, or the same quantity of dry mealworms. He hypothesized that drongos fed water-enriched mealworms would have a greater capacity for evaporative cooling, and therefore might subsequently be able to maintain higher levels of foraging activity than those fed dry worms. Instead, Ben's results showed that drongos fed water-enriched mealworms reduced foraging activity to a greater extent at high air temperatures than those fed dry mealworms. This surprising result suggests that water, rather than energy, is limiting for drongos when it is hot, such that birds will continue to forage during the heat in order to increase their water intake, but not their caloric intake. Ben continued to make good progress towards the completion of his PhD.

CB MSc student (2022/23 cohort) Bruce Chrispo, co-supervised by Ben and by Susie Cunningham and Chima Nwaogu, successfully completed his thesis on the impacts of temperature on nest success in the drongos and graduated in December 2023.

Also working in the Kalahari was CB MSc student Kim Daniels (2022/23 cohort). Kim completed her work on the potential for mistletoes *Plicosepalus kalachariensis* to provide thermal refuges for small birds in the southern Kalahari. She discovered that mistletoe clumps were cooler during the heat of the day and had a different humidity profile from their blackthorn *Senegalia melifera* host shrubs and from non-host blackthorns. Despite this, patterns of use of mistletoes and blackthorn by small birds (including Black-chested Prinias *Prinia flavicans* and Kalahari Scrub-robins *Cercotricha paena*) suggested that mistletoes were mostly targeted by birds as a foraging resource rather than a thermal refuge, at least under the conditions Kim encountered during her study period. Kim submitted her thesis in 2023 and graduated in December. She is currently working together with post-doc Mia Momberg to publish these results, together with a dataset collected by Mia on mistletoes in the Lowveld.

Continuing the theme of temperature effects on Kalahari bird behaviour, former PhD student Dr Amanda Bourne continued her incredible publishing record, with two further papers published during 2023 using data collected from the Southern Pied Babblers *Turdoides bicolor* at Kuruman River Reserve during her PhD. Amanda showed that helpers reduce helping behaviour more than parents during hot weather, explaining why group size does not seem to buffer adverse environmental conditions on breeding success in this species (published in *Behavioral Ecology*),

PhD student Ben Murphy works with a Fork-tailed Drongo to understand how hydration status affects behaviour during hot weather (Photo: Russel McClaughlin).

and documented a new thermoregulatory behaviour in this species *(*published in *Ostrich*). Further information on Pied Babbler research can be found at page 17.

The HBRP also conducted research on bird behaviour in mesic environments during 2023. MSc student Nazley Liddle submitted her thesis on interactions between temperature and humidity on thermoregulation and behaviour in Blue Waxbills *Uraeginthus angolensis* and other small mesic savanna bird species in humid northern KwaZulu-Natal. Nazley showed that Blue Waxbill thermal tolerance limits under humid conditions were lower than under dry conditions, and that they are therefore at greater risk under climate warming than previously predicted. Nazley also found complex, species-specific behavioural responses to increased heat and humidity among the mesic savanna bird community, with many species changing behaviour in response to both heat and humidity, but few common themes in the direction and strength of these responses.

Red-list species and mitigation interventions

The impacts of climate change are becoming ever clearer with extreme events including heatwaves, fire and flooding now a regular occurrence. There is no time left for a 'wait and see' approach to conservation in the face of climate change for already-threatened species. In 2023, the HBRP continued efforts to engage in research on red-listed species, and in development of conservation mitigation tools.

CB MSc student (2022/23 cohort) Michelle Bouwer submitted her thesis on the impacts of temperature and land-use change on hatching success in Blue Cranes *Anthropoides paradiseus*, graduating in December. She discovered that hatching success was negatively correlated with air temperature, and with increasing time parents left eggs unattended. This suggests both disturbance and climate change may impact future hatching success in the stronghold Overberg population. More information on Michelle's work can be found in "Impacts of Power Infrastructure" [Page 31].

CB MSc student (2023/24 cohort) Obakeng Pule continued work on the Southern Yellow-billed Hornbill *Tockus leucomelas* population at Kuruman River Reserve, previously studied by PhD students Tanja van de Ven and Nicholas Pattinson (2012–2021). Tanja and Nick found that hornbills are severely negatively affected by hot weather during breeding, with >50% of nests failing when average air temperatures during the nesting period exceeded 35°C. Tanja used path analysis to establish that 70% of the effect of air temperature on nest success occurred via direct effects of hot nestbox temperatures on nestling growth. Nick trialled a new insulated nestbox design during his PhD and found significantly weaker air temperature effects on nestling growth than Tanja had documented. However, the effect of the new nest box design used by Nick versus the old design used by Tanja, was confounded by the enormously variable weather conditions experienced in each study. Obakeng was funded by a WWF-USA Wildlife Adaptation Innovation Fund grant to experimentally assess the impact of box design itself, by monitoring nestling growth and nest outcomes in both uninsulated (old design) and insulated (new design) nestboxes in the 2022/23 and 2023/24 breeding seasons.

Obakeng's preliminary results suggest that seasonal differences have large impacts on chick growth and nest outcomes over and above differences in box type. However, nests in insulated boxes are more likely to succeed than those in uninsulated boxes within the same season. Nestlings in insulated boxes also weigh more than those in uninsulated boxes, especially in the first few weeks of life. This is associated with buffering of negative temperature effects on very young nestlings (~1 week old) in insulated boxes. These promising preliminary results suggest nestbox insulation might be a cheap and effective way to improve breeding success under rising temperatures in nestbox-dependent species.

Carrie Hickman continued her PhD data collection on Southern Ground Hornbills *Bucorvus leadbeateri* in 2023, confirming that high temperatures cause these birds to display heat dissipation behaviour year-round (even in winter), and that their thermal thresholds for engagement in heat dissipation behaviour in winter are lower than in summer. In 2023, Carrie also collected data on operative environmental temperatures by placing black bulb thermometers in different microsites at midday in summer and winter (sun, shade, at different levels off the ground), and assessed the availability of these microsite types in each season. Using these data, she was able to show that environmental

PhD student Wesley Gush and co-supervisor Melissa Whitecross fitting a GPS-GSM tracker to a secretarybird near Calvinia (Photo Melissa Whitecross).

temperatures were higher in winter than in summer, for the same air temperature. This is because there is less shade available in the environment in winter, due to the large number of deciduous trees in this habitat. This may explain why ground hornbills pant at cooler air temperatures in winter than they do in summer.

Carrie also showed that winters are warming faster than summers in the lowveld, highlighting an unexpected avenue of vulnerability for birds in this region. Carrie is also working on impacts of temperature on maternal investment in eggs, and on nestling growth and physiology. At the time of writing, she is engaged in her final field season of data collection for these aspects of her study.

In 2023 we started a new project on the implications of warming temperatures for Secretarybirds *Saggitarius serpentarius*, led by PhD student Wesley Gush. Wesley will be studying effects of warm weather on parental care and nestling growth, fitting GPS trackers including accelerometers to fledglings to study impacts of weather on behaviour during the critical early years post-fledging, and assessing thermal tolerance in adult Secretarybirds using respirometry. In 2023, Wesley collected his first data from active Secretarybird nests in the Karoo nearby Calvinia. He placed trail cameras at nests and deployed trackers on five nestlings. At the time of writing, two of these have fledged and flown northwest towards Vryburg. Wesley has also begun training captive adult birds at Dullstroom Bird of Prey Centre to sit calmly in custom-designed respirometry chambers ahead of collecting thermal physiology data in 2024.

In a final highlight of 2023's HBRP red-list species programme, Susie Cunningham and Peter Ryan were awarded a South African National Antarctic Programme grant from the NRF to start research on implications of climate change on the iconic surface nesting seabirds of Marion Island in 2024, including Northern and Southern Giant Petrels *Macronectes halli* and *M. giganteus* and Wandering Albatrosses *Diomedea exulans*.

Thermal physiology

A major theme for 2023 was understanding how the evaporative cooling capacity of forest birds is affected by humidity, reflecting the HBRP's increasing expansion into mesic habitats. High atmospheric humidity severely limits the ability of animals to dissipate heat by evaporation, compared to under dry conditions, and exposes them to greater risk of body temperature exceeding lethal limits. For instance, humidity has been a major contributing factor to increasingly frequent heat-related mortality events among flying foxes in eastern Australia and is also

thought to have exacerbated the conditions that led to South Africa's first known die-off of wild birds in northern KwaZulu-Natal in November 2020. Several HBRP projects during 2023 focused on understanding how birds respond to a combination of high air temperature and elevated humidity, conditions becoming more frequent as climate change advances. One highlight of the year was the acceptance of a paper emanating from Marc Freeman's PhD in the high-impact journal *Ecology*.

Bianca Coulson completed her MSc on thermoregulation in Trumpeter Hornbills *Bycanistes bucinator*. Working at St Lucia on the east coast, she measured Trumpeter Hornbills' body temperature, evaporative water loss and metabolic heat production over a range of air temperatures and humidities matching those they experience naturally. At humidity representative of average summer conditions, the hornbills were easily able to regulate body temperature, even at air temperatures equivalent to the thermal conditions they experience at midday in the sun. However, when humidity approached the upper extremes of values recorded in the area over the last 20 years, the hornbills' capacity to defend body temperature at safe levels virtually disappeared, leaving them unable to avoid severe lethal hyperthermia. Bianca's data have also yielded the first estimate of maximum wet bulb temperature for a bird. This variable combines temperature and humidity into a single number and is widely used in analyses of human thermal safety. The maximum wet bulb temperature thought to be survivable by humans is 35°C. The corresponding value for the hornbills, however, is 32°C. Mapping the hornbills' future exposure to this threshold value across their entire range reveals that several regions will become too hot and humid for the birds to persist by the end of the century.

Another highlight for 2023 involved Shannon Conradie and Andrew McKechnie contributing to a global analysis of risks posed by climate change to arid-zone birds published in *Nature Communications*. This study, which linked dehydration risk assessments with desert avian diversity patterns, identified areas in the world's deserts that will act as thermal refugia in coming decades, and evaluated the extent to which current protected areas include these future refugia. At present, less than 20% are protected, but the analysis presented in this study will hopefully aid the identification of new protected areas in future.

Modelling climate change impacts

Predicting the impacts of rising temperatures and more frequent extreme weather events on birds and other animals requires a detailed understanding of how birds operate in the thermal landscapes they occupy, and how heat transfer between those landscapes and birds constrains their ability to survive and reproduce. In 2023 Shannon Conradie continued work developing methods to assess the amount of empirical behaviour data required to ensure model predictions of thermoregulatory costs are accurate under complex field conditions. Preliminary results suggest detailed focal data are needed for biophysical models to accurately predict daily energy expenditure in Southern Pied Babblers *Turdoides bicolor* under field conditions, but fewer data are needed if these are strategically sampled across days of different maximum daily air temperature. Shannon is also working on how to include drinking behaviour to ensure accurate modelling of water costs, using empirical data from White-browed Sparrow-weavers *Plocepasser mahali*, and working on assessing the capacity of biophysical modelling to

Conservation Biology MSc student Obakeng Pule checking the status of a Southern Yellow-billed Hornbill nesting attempt in an insulated nest box at Kuruman River Reserve (Photo: Ben Murphy).

predict breeding outcomes of bird populations based on remote sensing data of conditions in the field.

Shannon Conradie and Susie Cunningham co-supervised BSc Hons student, Martiné van den Berg. Martiné assessed whether detailed species-specific morphometrics could be substituted with more general measurements from model species in the parameterization of biophysical models. She found that models parameterized with plumage measurements from House Sparrows *Passer domesticus* were just as successful at predicting White-browed Sparrow-weaver body temperature and evaporative water loss under respirometry conditions as those parameterized with plumage measurements from the sparrow-weavers themselves, suggesting that it may be possible to use generalized measurements for some model parameters under the right conditions. Martiné was awarded a Distinction for her work.

Highlights:

- The HBRP published 17 papers in international peer-reviewed journals in 2023, including *Global Change Biology, Nature Communications, Ecology, Behavioral Ecology* and more.
- Susie Cunningham was promoted to Associate Professor and Director of the FitzPatrick Institute.
- Ben Murphy won Best Presentation by a PhD student at the Learn About Birds Conference held in Wilderness in May.
- CB MSc student Sean Morar graduated in March 2023 and CB MSc students Michelle Bouwer, Bruce Chrispo and Kim Daniels all graduated in December 2023.
- MSc students Nazley Liddle, Jaimie Whyte and Bianca Coulsen all submitted their theses.
- Martiné van den Berg, Bianca Coulsen and Jaimie Whyte were all awarded their degrees with Distinction (we still await Nazley Liddle's results at the time of writing).
- Wesley Gush began a new PhD studying climate change impacts on Secretarybirds.
- Wesley Gush and Carrie Hickman were both successful in attracting Rufford Foundation funding for their projects on Secretarybirds and Southern Ground-hornbills, respectively.
- Susie Cunningham and Peter Ryan were successful in attracting a SANAP grant for research on on-island impacts of climate change on albatrosses and giant petrels on sub-Antarctic Marion Island in 2024.
- Susie Cunningham was awarded a WWF-USA Wildlife Adaptation Innovation grant to assess impacts of providing insulated nest boxes on Southern Yellow-Billed Hornbill nest success.
- Andrew McKechnie was elected to the Council of the Royal Society of South Africa.
- Shannon Conradie was short-listed as one of the top three applicants for the prestigious Jennifer Ward Oppenheimer Research Grant.

Key co-supporters

SARChi Chair in Conservation Physiology; UCT URC; U. Pretoria; NRF Thuthuka Grant; Francois van der Merwe; John Solomon; WWF USA; Rufford Foundation; VC Future Leaders Programme, UCT; Associated Private Nature Reserves.

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Global change and urban birds

Urban environments create novel challenges and opportunities for wildlife. Understanding why and how some species adapt to urban landscapes, but others do not, is important to predict how ongoing urbanisation is likely to impact birds. This project aims to understand how birds in human-altered landscapes cope with the opportunities and pressures of urban life.

The Red-winged Starling project

Red-winged Starlings *Onychognathus morio* have developed a reputation amongst the UCT community for being sly, lunch-thieving pests – but they are apparently also remarkably successful in highly urban environments. Since 2017 we have studied how these birds cope with highly variable food quality and quantity in urban environments, the stresses of sharing their space with large numbers of people, and of high summer temperatures as Cape Town's climate warms. Early correlative work showed that adult starlings benefit from high availability of anthropogenic food, gaining more weight on weekdays than on weekends, but that chicks seem to suffer, with those experiencing many high human presence days while in the nest showing reduced growth compared to those raised during lower human presence days (i.e. those whose nestling period overlaps with public holidays and vacations). We also found that more built-up areas on campus were occupied by larger birds, suggesting that starlings perceive these areas to be higher quality. Indeed, faecal glucocorticoid metabolite concentrations in starling droppings are negatively correlated with human foot traffic levels outside of the breeding season; suggesting that starlings suffer reduced stress in the presence of high human numbers, perhaps because of the ready availability of anthropogenic food or because humans deter natural starling predators.

However, even though adults benefit from high human presence on campus, nestlings appear to be negatively affected, and experimental work (e.g. by Miqkayla Stofberg over the last several years) has not clarified whether food quality or other correlated urban stressors are to blame. In 2023, MSc student Abiodun Ademola continued her work testing the hypothesis that negative impacts of high human presence on nestling growth may be mediated by stress effects associated with adult nest defence behaviours (breeding adults frequently divebomb passers-by when nests contain nestlings). Abiodun also continued data collection on behaviour and stress levels of adult starlings both inside and outside of the breeding season.

The starlings again played an important role in undergraduate and postgraduate teaching in 2023. Susie Cunningham led a third-year project on the BIO3013F Global Change Ecology course looking at starling responses to hot weather on campus. This project teaches 3rd-year students how to collect and analyse behaviour data from free-living animals. This was the 8th year this project has run (2015–23, with a 1-year Covid-19-related hiatus) and it is becoming apparent that starlings adjust the onset of heat-dissipation behaviours annually in relation to the prevailing weather conditions that year, suggesting a great deal of behavioural plasticity in heat-load management. Dr Celiwe Ngcamphalala used our annual starling 'catch week' in mid-winter to expose Biological Sciences Honours students to methods used to study avian stress physiology, inviting the students to take part in catching efforts and observe and record data on blood-sampling, measurement and ringing, to aid their understanding of invasive versus non-invasive methods of studying wild animals.

Anthropogenic food as a resource for urban birds

In addition to her work on the starlings, Miqkayla Stofberg's PhD research attempted to better understand the importance of anthropogenic food in allowing bird species to adapt to living in urban environments. Miqkayla undertook a review of the literature and extracted the proportion of urban birds' diet that is made up of anthropogenic food. She then explored which traits are most closely associated with the propensity to consume these types of food.

Interactions between urbanisation and climate change

Rapid urbanisation is a major feature of anthropogenic global change in the current century. Another is rapid and ongoing climate change. These two global change drivers do not act in isolation and impacts of climate change on wildlife could be exacerbated, or buffered, in urban areas. This is

MSc student Abiodun Ademola weighing Red-winged Starlings on Upper Campus. (Photo: Abiodun Ademola).

because major changes in habitat structure, food and water availability, disease exposure and species interactions and pollution (light, sound and chemical) may all affect how wildlife can respond to rising temperatures and changing weather patterns. Additionally, urban environments tend to be hotter than surrounding natural landscapes (the 'urban heat island effect'), except in arid areas where they may be cooler. The UCT starling team and collaborators in Sweden co-authored a major perspectives paper in the journal *Global Change Biology* highlighting how we might expect the forces of urbanisation and climate change to interact in their effects on wildlife. This paper has already attracted numerous citations and we hope it will inspire further research in this area.

Activities in 2023

- Abiodun Ademola continued her MSc project which focuses on understanding the effect of fluctuations in human foot traffic on stress levels in adult and nestling Red-winged Starlings, using faecal glucocorticoid metabolites as a proxy for stress. She is also investigating the downstream impacts on fitness by measuring body mass changes and reproductive success. Abiodun is supervised by Susie Cunningham and Celiwe Ngcamphalala.
- A highly successful trapping effort in mid-2023 saw 35 new colour-ringed starlings added to the study population, bringing the total number of adults starlings ringed during the course of the project to 312. An additional 55 nestlings were ringed in the nest in 2023.
- Body mass maintenance and breeding monitoring continued throughout 2023: these data will be used to investigate the effects of societal recovery from the COVID-19 pandemic on the productivity of urban wildlife, and, in the long term, to assess how climate change and urbanisation together impact fitness of urban wildlife.

Highlights:

- Miqkayla Stofberg graduated with her PhD entitled 'The influence of anthropogenic food on bird behaviour and community structure in urban environments' and presented one of her chapters at the BirdLife South Africa LAB meeting in Wilderness.
- The team published a paper on the impacts of urban-climate change interactions on wildlife in a leading journal, *Global Change Biology.*

Impact of the project

Studying the starlings 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. In addition, the starling project supports teaching at undergraduate (third year) and post-graduate (honours) levels, exposing students to the skills needed for field ornithology.

Key co-supporters
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A/Prof. Robert Thomson (FIAO, UCT)
Dr Hannah Watson (MEEL, Lund University)

Students: Miqkayla Stofberg (PhD, UCT); Jessleena Suri (PhD, UCT); Abiodun Ademola (MSc, UCT).

Volunteers: Babette Fourie, Daniella Mhangwana, Joel Radue, Mila Truter, Sam Wagstaff, Kyle Walker and many others.

Plastics in the environment

Plastic litter persists for many years, is readily dispersed by water and wind, and has been accumulating in the sea for decades, where it gradually breaks down into 'microplastics'. It entangles and is eaten by a wide diversity of aquatic fauna, killing them directly, or reducing their appetite. Concerns about microplastics introducing persistent organic pollutants (POPs) into aquatic foodwebs, combined with the discovery of 'garbage patches' in all the main ocean gyres, has sparked renewed interest in the subject. This project aims to understand and monitor plastic pollution with a view to reducing the amount entering 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 serious environmental and economic threat. The most significant threat arises from plastic ingestion, so it is important to understand why organisms ingest plastic. Vonica Perold's PhD is comparing plastics ingested by seabirds with those found in the environment, and assessing changes in ingested plastic since the 1980s. However, although much remains to be learned about the impacts of plastics on aquatic ecosystems, we know enough to act to reduce waste plastic entering the environment.

Reducing plastic pollution depends on changing human behaviour through education, policy interventions, incentives, etc. Fitz researchers have developed indicators for the levels of environmental plastics, to feedback on whether measures introduced to reduce plastic leakage are effective. We monitor plastic in the environment – through interactions with biota as well as sampling at sea and on beaches. We also infer the origins of 'general' marine litter, which could come from a variety of sources, through use of bottles and lids as indicators. Knowing where marine plastic comes from, and how it disperses through the environment, is crucial to target mitigation measures.

A more applied project, funded through the South African Waste Research Development and Innovation Roadmap, is testing the efficacy of litter booms and other passive interception devices to trap litter in rivers and storm drains. This project is also using estimates of urban litter loads to identify key sites for the installation of additional litter traps to reduce the release of land-based litter into the sea.

Activities in 2023

- After a two-year break on Gough Island, Vonica Perold made good progress on her PhD on seabird plastic ingestion. She submitted one paper on the use of skua pellets as a way to monitor ingested plastic in South Atlantic seabirds, and has a second paper reporting long-term trends in these species ready to submit.
- CB MSc student Abigail Campbell assessed long-term changes in plastic ingestion among White-chinned Petrels *Procellaria aequinoctialis.* This is the bird species most often killed on fishing gear off southern Africa, providing a rich data set over the last two decades.
- Kyle Maclean upgraded to a PhD, thanks to an NRF bursary from Prof. Cristina Trois, SARChi Chair for Climate Change and Waste Management at UKZN. Kyle has expanded his original focus from the amounts of litter intercepted in rivers and storm drains to include

Seabed litter, including large numbers of PET bottles, washed ashore during upwelling conditions at Muizenberg (Photo: Peter Ryan).

surveys of the amounts of street litter generated in four areas in Cape Town, across the socio-economic spectrum. He is also assessing attitudes to litter and littering in these four communities in collaboration with Prof. Rinie Schenck, SARChi Chair in Waste and Society at UWC.

- MSc student Chukwudi Nwaigwe completed field sampling for his study of the amount and composition of litter contributed to beach litter loads by beach goers. He used daily accumulation studies at two adjacent beaches with different numbers of users and compared litter loads in 2022/23 with those when beaches were closed during the COVID-19 pandemic. During summer 2022/23 he also repeated Antonio Massot-Mascaro's 2013/14 MSc study of surf zone litter in False Bay to assess the importance of offshore export of beach litter.
- Peter Ryan used some of his newly-acquired free time to start writing up the backlog of plastics data he has collected over the last few years.

MSc student Chukwudi Nwaigwe completed his collection of litter at two Muizenberg beaches to tease apart the contribution of beachgoers to beach litter loads (Photo: Chukwudi Nwaigwe).

Highlights:

- CB MSc student Shaidan Gonlag graduated, and is working on expanding his project to include the latest data from informal settlement street litter for publication.
- PhD student Kyle Maclean celebrated the arrival of his daughter, Lila.
- Five papers were published in 2023, and another was accepted for publication.
- Two papers summarised surveys of plastics at sea. Former MSc student, Eleanor Weideman, led on a paper reporting the distribution and abundance of microplastics off the coasts of Mozambique and Tanzania, and long-time collaborator Giuseppe Suaria led on a paper covering the eastern Atlantic Ocean.
- Peter Ryan published a paper using bottles as litter tracers, showing that illegal dumping from ships is responsible for most drink bottle litter even far from shipping lanes, based on data he collected on the Pitcairn islands in 2019. He also drafted a summary document with Maëlle Connan and collaborators in Australia showing how littering from ships is pervasive throughout the Southern Hemisphere, which was tabled at the UN Plastics Treaty negotiations.
- Peter also completed a paper showing how foreign drink bottle lids indicate a different litter source than foreign drink bottles on South African beaches; while most bottles are made in China, Singapore/Malaysia and the U.A.E., and are dumped illegally from ships, almost all loose lids come from Indonesia, having drifted across the Indian Ocean.
- The revised African Marine Litter Monitoring Manual, featuring several chapters co-authored by team members, was published by the Sustainable Seas Trust.

Key co-supporters

South African Department of Science and Innovation, through the Waste RDI Roadmap, managed by the Council for Scientific and Industrial Research (CSIR); Commonwealth Litter Programme (CLiP); United Nations Environment Programme.

Research team 2023

Emer. Prof. Peter Ryan (FIAO, UCT)
Emer. Prof. Coleen Moloney (Biological Sciences, UCT)
Dr Maëlle Connan (NMU)
Dr Lorien Pichegru (NMU)
Dr Patrick O'Farrell (FIAO, UCT)
Dr Giuseppe Suaria (CNR-ISMAR, Italy)

Students: Vonica Perold (PhD, UCT); Kyle Maclean (PhD, UCT); Chukwudi Nwaigwe (MSc, UCT); Abigail Campbell (CB MSc, UCT).

Understanding the ecological impacts of Pied Crows

Pied Crow *Corvus albus* numbers are increasing in many parts of South Africa. Recent work at the Fitz suggests that the increase in Pied Crow numbers is a result of global warming and other anthropogenic factors, including the availability of nest sites on electrical infrastructure and increased food availability in urban areas and from road kills. In combination, these factors have seen the Pied Crow increase its abundance in some regions and expand its range locally. Our project investigates the expansion of this species, sometimes termed a 'native invader', and aims to understand what impacts these changes might have for biodiversity. Previous Fitz research has focused on quantifying predation on tortoises and avian nest predation. Our current research builds on that research, which suggested that crows may benefit from scavenging on the carcasses of road kills. We also work to gain a broad understanding of public perceptions on Pied Crows and their potential management.

As a generalist predator, Pied Crows may impose heavy predation pressure on a variety of prey species. Anecdotal evidence suggests that Pied Crows present a risk to threatened species, such as endangered breeding waders and range- restricted tortoises. Because they may prey on species that are important for processes like seed dispersal, increases in crow numbers may influence ecosystems, generally. Researchers and conservation organisations have begun drawing attention to the knowledge gap with regards to the ecological impacts of Pied Crows, emphasising the need for more studies. Indeed, there is little information about the basic life history of Pied Crows, which is an essential component for understanding the potential impacts of a predator. We aim to contribute to filling these knowledge gaps.

Activities in 2023

- Temitope Adelola conducted an online survey which aimed to understand perceptions of the South African public about Pied Crows, their abundance trends and potential impacts on biodiversity and livestock. The survey received almost 1 200 responses from every province in South Africa. This response was due partly to the incorporation of the Pied Crow in BirdLife South Africa's 'Birdle' game which included a link to our questionnaire.

Highlights

- Temitope completed her analysis of Pied Crow abundance and breeding success in relation to roadkill abundance on tarred and gravel roads. This work forms one of Temitope's MSc chapters, which will be submitted in 2024.
- Yusra Samsodien has been awarded a Joan Wrench Scholarship through SANBI. She will register for a MSc and work on Pied Crow ecology in early 2024. Part of her research will use SABAP2 data to explore how changes in Pied Crow populations have occurred over the last 15 years.

Impact of the project

This research aims to improve our understanding of the drivers of increasing Pied Crow abundances in certain regions of South Africa and determine the associated implications for conservation, and if so, what management actions might be most effective to deal with these concerns.

Key co-supporters

Mastercard Foundation, BirdLife South Africa.

Research team 2023

A/Prof. Robert Thomson (FIAO, UCT)
A/Prof. Arjun Amar (FIAO, UCT)
Kyle Walker (FIAO, UCT)
Rona van der Merwe
Student: Temitope Adelola (MSc, UCT)

A bumper crop of 5 PhD, 4 MSc by dissertation and 25 CB MSc students were capped at the graduation ceremonies during 2023. Congratulations to all!

Conservation Biology Masters programme 2023

The 2023 intake of Conservation Biology Masters (CB MSc) students comprised 13 students from eight countries: South Africa, Ghana, Zambia, Kenya, France, the Netherlands, the UK, and the USA. This was the first cohort since that of 2019 to complete their entire year free of COVID-19 restrictions, although some classes did have to be moved online because of campus disruptions and problems related to load shedding (minimum 2.5 hour power outages caused by a shortage of generation capacity to meet the country's electricity demand). All students completed the coursework successfully, and five students (38% of the class) achieved distinction grades in the coursework. Congratulations all!

Course structure and teachers

The course continues to be taught by a wide range of module leaders from within and outside UCT. In 2023, the module leaders were: Arjun Amar (Statistics and Project Planning); Colin Attwood (Marine Conservation); Jacqui Bishop (Conservation Genetics); David Cumming (Big Picture and Philosophy of Science); Susie Cunningham (Biodiversity Basics); Wendy Foden (Conservation Leadership); Dalton Gibbs (Urban Conservation); Lindsey Gillson (Climate Change); Timm Hoffman (Community Ecology); Mlungele Nsikani (Restoration Ecology); Patrick O'Farrell (Landscape Ecology and GIS); Justin O'Riain (Conservation Conflicts); Sebataolo Rahlao (Biological Invasions); Peter Ryan (Demography and PVA); Jeremy Shelton (Freshwater Conservation); Claire Spottiswoode (Project Planning); Gladman Thondhlana (Conservation and Society); and Jane Turpie (Resource Economics). Many others contributed through guest lectures, field trips and discussions. This diversity of perspectives adds greatly to the course.

Challenges and opportunities

In April 2023, Susie Cunningham, who had been ably convening the CB MSc course for eight years, stepped into the role of Fitz Director, leaving a rather large hole in the form of a CB MSc course convenor. Fortunately, she was able to persuade the university that filling this role immediately she left it and at very short notice was essential, which made it possible to employ Dr Sally Hofmeyr in that capacity, on a half-time, fixed-term contract. Ultimately, this role should be filled by a full-time academic, but given the short notice and funding

The CB 2023 cohort reach the end of their coursework component with a mixture of sadness and relief (Photo: Jacqui Bishop).

constraints, as well as the need for some continuity across years, the university agreed to this appointment as an interim arrangement. Sally did her PhD and a Postdoctoral Fellowship in the erstwhile Animal Demography Unit and has maintained an *ad hoc* involvement in the Fitz since leaving in 2015, particularly since 2018 as a fieldwork technician with the Red-Winged Starling Project. With assistance from Susie and Hilary, Sally managed to shepherd all the students and module leaders to the end of the year with great success! She has greatly enjoyed being a part of this excellent programme and interacting with all the people involved, not to mention being a more formal part of the Fitz.

Highlights

- Research done by CB MSc students for the dissertation component of their degree continues to produce publication-quality results. In 2023, three papers were published by CB students in international journals (*PLoS ONE, Journal of Arid Environments,* and *Environmental Pollution*). As ever, we are proud of the work our students are producing and the impact they have in the field of conservation biology globally.
- All 13 of the 2023 cohort of students successfully completed the coursework component of the degree. Five of the students achieved distinctions for their coursework.

MSc Conservation Biology projects 2023

Tevin Adams: Space and resource use of Cape Vultures at an isolated colony in the Western Cape: importance of livestock agriculture to this thriving population (Supervisors: Arjun Amar, Robert Thomson).

Zoe Allouchery: Driving giants: spatial and temporal variables influencing giraffe movements in a private protected area (Supervisors: Jacqueline Bishop, Susan Miller, Gabriella Leighton).

Abigail Campbell: Long term changes in the incidence and characteristics of plastic ingested by white-chinned petrels (Supervisor: Peter Ryan).

Alexandro Faria: Reviving giants, reclaiming carbon: exploring the synergy of megafauna, soil carbon, rewilding (Supervisors: Charlene Janion-Scheepers, Guy Midgley).

Mpho Havhi: Community distribution along hydrological gradients in a groundwater-fed wetland in the Cape Floristic Region (Supervisors: Adam West, Karl Reinecke, Justin van Blerk).

Wiro-Bless Kamboe: Partnership, companion, or enemy: how and why do people differ in their relationship with honeyguides in northern Ghana? (Supervisors: Claire Spottiswoode, Jessica van der Wal, Timothy Aikins Khan).

Casper Morch: Between a bass and a hard place: the fragmented distribution of an endangered redfin in the Heuningnes river system of the Cape Fold ecoregion (Supervisors: Charles Griffiths, Jeremy Shelton).

Choolwe Mulenga: Factors influencing cheetah distribution in Kafue National Park (Supervisors: Justin O'Riain, Zoe Woodgate, Kim Young-Overton, Sarah Durant).

Maggie Mwale: Have birds' eggs become paler as the climate warms? (Supervisors: Claire Spottiswoode, Shannon Conradie, Nicholas Horrocks).

Obakeng Pule: Handling the heat: managing microclimates for nesting desert hornbills (Supervisors: Susie Cunningham, Celiwe Ngcamphalala, Ben Murphy).

Lawrence Steyn: Tails through time: Leopard population dynamics in the Little Karoo (Supervisors: Greg Distiller, Kathryn Williams, Anita Wilkinson, Gareth Mann, Sally Hofmeyr).

Wambui Waibochi: Habitat selection of wild dogs outside protected areas: implications for land-use policy (Supervisors: Jacqueline Bishop, Tim Kuiper, Dave Druce).

Robi Watkinson: Crouching leopard, hidden camera: Comparing methods for estimating leopard density in a small reserve (Supervisors: Justin O'Riain, Zoe Woodgate, David Cumming).

Niven Library

The Niven Library is often touted as the largest ornithological library in the Southern Hemisphere. Named after Dr Cecily Niven, the main architect of the FitzPatrick Institute of African Ornithology, it houses the joint collection of the Fitz and BirdLife South Africa. The main reading room also serves as a meeting place for staff, students, and visitors as it hosts Fitz social functions, meetings, seminars, the annual general meeting, and occasional classes.

A lively library: analogue and digital

This year, a lot of thought and effort went into reviving the Fitz community after the COVID-19 lockdown and the associated work-from-home trend took hold. The Niven library was offered as a venue to assist in encouraging staff members and students to return to regular 'in-person' office hours and meetings. A variety of meetings, seminars, and social gatherings took place in the library: from staff meetings to Honours classes, the Fitz Annual General Meeting, Conservation Biology student presentations, visiting scholars' talks, and the newly named, twice-monthly social gathering: 'Thirsty Thursday'.

The 2023 MSc CB class after presenting their projects to the staff and students in the Niven Library. (Photo: Susie Cunningham).

All things digital

There were three main accomplishments in the digital sphere this year.

1. The digital reference service continues to thrive, with close to 300 files being sent to 49 researchers, both nationally and internationally.
2. Meetings were held and agreement was reached regarding how the Nest Record Card collection will be presented online. Uploading will begin in 2024.
3. Scanning of Peter Steyn's collection of slides and negatives began in earnest when a slide scanner was installed in the library.

A digitised slide from the Peter Steyn Collection. Fork-tailed Drongo

ABB is three!

Afrotropical Bird Biology (ABB), the Fitz-run online journal managed by the librarian, is now well-established. Volume 3 was published this year, comprising two research articles and five short communications. There were 1932 downloads from volumes 1 to 3 in 2023, with a report by Clive Barlow et al on a Hooded Vulture scavenging event in the Gambia topping the charts at 215 downloads over the course of the year.

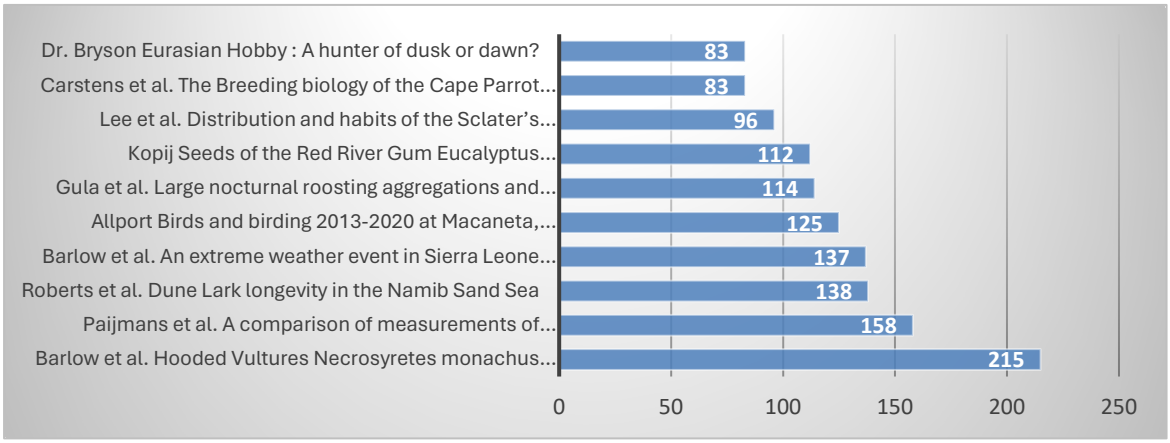

Figure 4: Number of downloads for the top 10 downloaded articles on ABB in 2023

Sharing Fitz datasets

Fitz authors are by now well acquainted with ZivaHub, UCT's data repository. With the librarian's assistance in the addition of metadata, moderation of submissions, and guidance on the process of submission, the total number of datasets contributed by the Institute rose from 39 to 50. These received a staggering 15 650 views and 9 094 downloads during 2023.

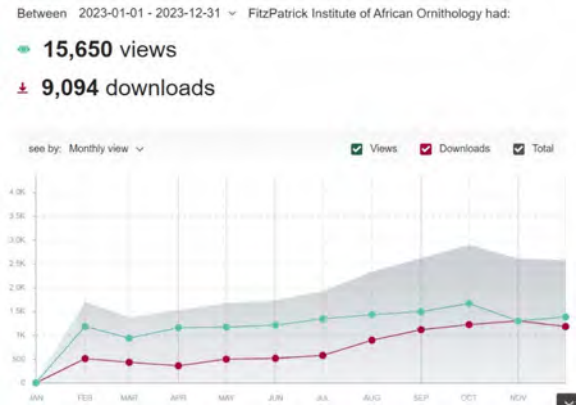

Figure 5: Number of views and downloads of Fitz datasets on ZivaHub in 2023: Monthly view

A beautifully bound donation from Peter Steyn: Andrew Smith's "Miscellaneous ornithological papers"

Generous donation

The library is immensely grateful to Peter Steyn, who invited us to browse the shelves of his substantial personal library and choose titles to be donated to us. In total, we received 24 valuable titles and two entire runs of journals.

Niven Library Staff 2023

Janine Dunlop (Niven Librarian)
Olufemi Olubodun (Part-time assistant)

SAFRING report

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

SAFRING has received primary ringing data from 185 bird ringers during 2023, but ringers continue to submit data for 2023 and this number is likely to increase slightly. A total of 13 new A-licence SAFRING ringers were registered in the calendar year. Thus far for 2023, primary ringing data were received from 13 African countries, with resighting or recapture data of ringed birds from another 18 countries, mostly in Europe, North Africa and the Middle East.

The SAFRING Steering Committee met during the year to help with guiding decision-making and prioritizing the work of SAFRING. The Steering Committee is made up of bird ringers linked to SAFRING who represent bird clubs, wildlife NGOs, provincial conservation departments, and ringers with special interests, such as bird rehabilitation.

Social media

In September 2023, we created a private Facebook group at the recommendation of the SAFRING Steering Committee. This group, reserved exclusively for registered SAFRING ringers, was devised as a "a safe place for SAFRING registered ringers to share experiences and discuss methods, techniques, or other issues privately". Anyone requesting access is required to submit their ringer number. By the end of 2023, 72 ringers had joined.

The public Facebook group continues to be both a valuable source of information and an effective platform from which to share information about resightings of live and recoveries of dead ringed birds. A minor change effected this year is that all posts are now moderated. The decision to add a step to publishing of posts was made in response to a spate of spam posted to the group as well as some comments that breached the group rules.

During 2023, the public Facebook grew from 1 315 to 1 455 members and 86 posts were published by members of the public, SAFRING ringers, and the group administrators. Comments and reactions to these posts amounted to 245 and 1 260 respectively.

There were many resighting posts from members of the public. These are particularly rewarding when they are sent by someone who, prior to making contact with us, was unaware of bird ringing and its value. A noteworthy sighting in 2023 was of a Black-browed Albatross that was spotted at sea approximately 45km off Cape Point. This bird had originally been ringed as a nestling by the British Trust for Ornithology on 30th December, 2006 at Bird Island, South Georgia and had travelled 4 838km in the last 16 years, 5 months and 7 days (5 997 days) since last being seen.

(Photo: Rene Rossouw)

SAFRING team 2023

A/Prof. Robert Thomson (Co-ordinator, FIAO, UCT)
Janine Dunlop (Niven Librarian, FIAO, UCT)
Kim Kelly Hunt (Research and Data Manager)
Michael Brooks (FIAO, UCT, SAFRING website maintenance)

SAFRING Steering Committee members:
Zephne Bernitz; Mark Brown (UKZN); Ursula Bryson (FIAO RA); Tammy Caine (FreeMe Wildlife); Brent Coverdale (KZN Wildlife); Johan de Jager (BirdLife North Gauteng); Chris du Plooy (BirdLife North Gauteng); Peter Hamming (Southern African Wildlife College); Alan Lee (BirdLife SA); Katta Ludynia (SANCCOB); Craig Nattrass (Vulpro; Wits Bird Club); Gareth Tate (EWT).

Southern African Bird Atlas Project (SABAP2)

The Southern African Bird Atlas Project (SABAP2) is an open content, citizen science project supplying data on bird distributions and reporting rates and informing bird conservation and research across southern Africa, including South Africa, Lesotho, eSwatini, Namibia, Botswana, Zimbabwe, Zambia, Malawi and Mozambique. Used by students, researchers, and consultants across various fields, this valuable resource contributes to the training of new scientists, conservation planning and environmental impact assessments, and research into the biology of birds and the well-being of their populations.

SABAP2 continued to grow in 2023. 1 091 Citizen Scientists surveyed 11 706 pentads and logged 918 species over the year. This amounted to 1.8 million sightings on 74 707 cards that were added to the database across the two protocols and, brought the total number of records to over 22 million.

This year also saw significant developments. The "BirdMap protocol" - the data collection protocol used by atlassers and pioneered by SABAP2 - has been adopted by the African Bird Atlas Project and implemented across numerous countries in Africa, ensuring continent-wide collection of interoperable data. Initiatives like the Kenyan Bird Map (2012) and the Nigerian Bird Atlas (2014) adopted these protocols in the mid-2010s, while Senegal launched its bird atlas project at the close of 2023. Formal projects are now underway in Sierra Leone, Liberia, Ghana, Uganda, and Egypt. Data collection has expanded to 49 of Africa's 54 countries. Each node across Africa operates independently, with the FitzPatrick Institute serving as host for the dataset and the central data hub for these projects.

Projects like BIRDIE, hosted by the South African Biodiversity Institute (SANBI), rely on this dataset to advance their goals. BIRDIE collects and analyses information on wetlands and waterbirds to offer valuable insights for local and international conservation and policy decision-makers. Using data from the SABAP2 and Coordinated Waterbird Counts (CWAC) projects, BIRDIE employs sophisticated statistical models to detect trends important to conservation management. These are presented through an online dashboard that provides access to near real-time indicators on bird distribution, abundance, and diversity at various wetlands. More information can be found at https://birdie.sanbi.org.za/.

The true champions of SABAP2 are the ditizen scientists, who contribute most of the data. Without their enthusiasm, dedication, hard work, and hours of commitment (92 552 hours in 2023), SABAP2 would not have achieved its current level of success. Whether they are broadening coverage in new or underrepresented areas or deepening our understanding of local areas, every contribution of data helps us gain insight into how environmental changes are impacting bird populations.

Like many projects of this magnitude, SABAP2 faces challenges, with funding being a particularly persistent one. Given that the project is designed to continuously collect data indefinitely, securing ongoing funding is imperative to ensure the continued operation of the foundational systems. We extend our thanks to the numerous patrons whose generous contributions have sustained the project. Without their support, the expansion and success of SABAP2 would not have been possible.

The growing list of publications using SABAP2 data can be found at http://sabap2.birdmap.africa/media/bibliography.

SABAP2 team (Admin)
Ernst Retief (Project Coordinator, BirdLife SA)
Tania Anderson (Project Coordinator SABAP2, CWAC, CAR, FIAO)
Michael Brooks (Chief Technical Officer, FIAO)

Scientific publications 2023

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 (2019, 2-year impact factor)

Online Journal Published Papers

Abucay, L.R., Sorongon-Yap, P, Kesner-Reyes, K., Capuli, E.C., Reyes, R.B. Jr, Daskalaki, E., Ferrà, C., Scarcella, G., Coro, G., Ordines, F., Sánchez-Zulueta, P., Dakalov, G., Klayn, S., Celie, L., Scotti, M., **Gremillet, D.**, Lambert, C., Gal, G., Palomares, M.L.D., Dimarchopoulou, D. and Tsikliras, A.C. 2023. Scientific knowledge gaps on the biology of non-fish marine species across European Seas. *Frontiers in Marine Science* 10. **IF: 3.7** https://www.frontiersin.org/articles/10.3389/fmars.2023.1198137

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