FitzPatrick Institute of African Ornithology

DSI – NRF Centre of Excellence

University of Cape Town

Annual Report 2021

FRONT COVER: **A Double-banded Courser *Rhinoptilus africanus* pants to cool down in the Namib Desert (Photo: Peter Ryan).**

Report Layout: Hilary Buchanan

Contents

Director's report

House Mouse on Gough Island

2020 was the year of COVID, and unfortunately the effects of the pandemic continued into 2021, despite the release of various vaccines. The Fitz adapted as best we could, delaying the start of the conservation biology course for five months to allow as much time as possible for conditions to improve. And indeed we were able to conduct face-to-face classes for much of the year, only resorting to online teaching during the height of the third and fourth waves. But for the most part, we continued to work and teach from home. We can only hope that 2022 will see the return to a greater degree of normality.

Despite COVID-related restrictions, life went on at the Fitz. We graduated 13 students: congratulations to Carina Nebel and Stefan Schoombie (PhD), Monique du Plessis and Jess Lund (MSc) and Jessica Burnette, Hannah Edwards, Varalika Jain, Tamar Kendon, Eliupendo Laltaika, Merlyn Nkomo, Imthiaz Sheik Abbass, Tom Thacker and Debbie Walsh (CB MSc). We're particularly proud of the CB graduates, as they bore the brunt of the 2020 COVID restrictions on face-to-face teaching. Monique du Plessis, Jess Lund, Vee Jain and Tom Thacker all received their degrees with distinction.

The number of publications in peer-reviewed journals decreased from a record high of 160 in 2020, but was still a respectable 138 papers in 2021, including 31 in journals with a two-year impact-factor greater than 5. The decrease can be attributed in part to the marked increase in fieldwork in 2021 compared to 2020, which reduced the time available for writing up; we'll see the fruits of this work coming out in the coming years. One COVID-related casualty was the Fitz annual general meeting, which was held online without the usual seminar series. However, many of our students were able to show off their work on a variety of online platforms, including a dedicated Fitz session at the African Bird Fair.

Staff-wise, 2021 was a stable year, but some time was devoted to preparing for the changes that will occur in 2023. I notified the Fitz board of my intention to step down as Director at the end of 2022, and a plan has been agreed upon to select a replacement. I hope to be able to remain associated with the Fitz in an emeritus position, but after a decade as Director it is time for new leadership to guide the Fitz in the post-CoE era. Mine will not be the only retirement at the end of 2022; Gonzalo Aguilar also will need to be replaced. Gonzalo joined the Fitz in a reshuffle among the senior support staff in the Department of Biological Sciences following Chris Tobler's retirement in 2014. In addition to looking after the Fitz computers and IT infrastructure, vehicle fleet, and other equipment, he also manages HW Pearson building. I am currently negotiating how his post will be filled.

Many at UCT will remember 2021 as the year of the fire. On 18 April a mountain fire severely damaged several buildings on UCT's upper campus, including gutting the former home of the Fitz on top of the HW Pearson Building. We were lucky to escape relatively unscathed – even the Fitz vehicles parked on campus at the time were not damaged. I missed most of the drama because I was on Gough Island at the time; I'm grateful to Claire Spottiswoode, who was acting Director in my absence, for keeping a cool head and managing the situation. We also have to thank Dalton Gibbs, who teaches the Urban Ecology module on the CB course, for real-time feedback on conditions on campus during the peak of the fire.

For me, 2021 was the year of the mouse. After being derailed in 2020 by COVID, the Gough Island Restoration Programme (GIRP), which was designed to eradicate mice from the island, finally went ahead. And the initiative to eradicate mice from Marion Island gained a huge boost with the appointments of Anton Wolfaardt as Project Manager, and Keith Springer as Operations Manager early in 2021. Both bring a wealth of experience to the project.

I joined the aviculture team on Gough, travelling to the island by yacht in early March. Our task was to establish captive 'insurance' populations of the island's two endemic land birds, the Gough Bunting and Gough Moorhen, before the eradication attempt took place. Most of the aviculture team left in January to finalise construction on the holding facilities; I was part of the team tasked with catching the birds, given my long-standing experience of catching buntings at Tristan and Gough.

After two weeks locked down in a hotel in Cape Town and eight days on the yacht, the catching was a breeze. We had the full complement of birds in captivity well ahead of the arrival in early June of the main eradication team, with its four helicopters and more than 200 tonnes of poison bait. I returned home, leaving the team to get on with the actual eradication attempt.

One of my main concerns was that there wouldn't be enough good weather days to spread the bait. Helicopters cannot spread the bait if it is too wet or windy, and of course there has to be adequate visibility for any flying at all – which is a tall order for the cloud-shrouded mountain peaks in winter. However, the weather played ball, and the first baiting of the island was completed by the end of June. Then it rained for most of July, and it looked like a second bait drop was in jeopardy. Fortunately, the weather cleared, and by early August the job was done.

Over the following months, the captive buntings and moorhens were released, and the seabirds flourished in the mouse-free conditions. Atlantic Petrels and MacGillivray's Prions, which typically suffer heavy chick mortality within a few days of hatching from mouse predation, raised most of their chicks. But then, in mid-December, came the devastating news that a mouse had been photographed by a baited camera trap near the research station. Hope that this was an isolated event was dashed when more mice were caught at several sites on the island. It seems that the eradication attempt failed.

Clearly this is very disheartening given the enormous amount of time and effort put into the project. It also has ramifications for Mouse-Free Marion, which still has to raise a substantial amount of funding to mount an eradication attempt on Marion. Over the last 15 years, more than 90% of rodent eradication attempts have succeeded, but there is always a chance of failure. Objectively, the failure on Gough does not materially affect the likelihood of success on Marion, but we need to learn as much as possible about the causes of the failure on Gough, and where contributing factors can be identified, work to ensure that these are avoided on Marion.

Critically, we cannot give up on the attempt at Marion. To do so would send the message that mouse eradications are too risky, setting back other eradication attempts. We need to make sure that Marion goes ahead and succeeds, so that we can consider another attempt at Gough Island, which remains one of the highest priority islands for rodent eradications worldwide.

Peter Ryan, February 2022

The former home of the Fitz atop the HW Pearson Building, which currently houses the Plan Conservation Unit, was gutted by the fire on 18 April 2021 (Photo: News24).

Staff, Students and Associates

UCT GRADUATES

PhD
Carina Nebel
Stefan Schoombie

MSc
Monique du Plessis (with distinction)
Jess Lund (with distinction)

Conservation Biology MSc
Jessica Burnette
Hannah Edwards
Varalika Jain (with distinction)
Tamar Kendon
Eliupendo Laltaika
Merlyn Nkomo
Imthiaz Sheik Abbass
Tom Thacker (with distinction)
Debbie Walsh

NEW UCT STUDENTS

PhD
Rebecca Muller (Arjun Amar)

MSc
Temitope Abisoye (Robert Thomson)
Kyle Maclean (Peter Ryan)
Sanjo Rose (Robert Thomson)
Emily Spencer (Peter Ryan)

Upgrade from MSc to PhD
Robin Colyn (Peter Ryan)
Samantha McCarren (Anina Coetzee)
Kailen Padayachee (Arjun Amar)

Conservation Biology MSc
Fourteen students began the CB MSc in May 2021.

BSc Hons
Cameron Blair (Claire Spottiswoode)
Rion Cuthill (Claire Spottiswoode)
Matthew Kennedy (Arjun Amar, Robert Thomson)
Kagiso Nhlapo (Susie Cunningham)
Mila Truter (Susie Cunningham)

Academic Staff

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

Academic and Research Staff:
Assoc. Prof. Arjun Amar, PhD (Aberdeen)
Dr Susan Cunningham, PhD (Massey)
Dr Chima Nwaogu, PhD (Groningen & St Andrews) (May-)
Prof. Claire Spottiswoode, PhD (Cambridge)
Dr Robert Thomson, PhD (Oulu)

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

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

Honorary Research Associates/Affiliates
Dr Phoebe Barnard, PhD (Uppsala)
Dr Diana Bolopo, PhD (Valladolid)
Dr Rita Covas, PhD (Cape Town)
Prof. Graeme Cumming, PhD (Oxford)
Dr Tom Flower, PhD (Cambridge)
Dr Wendy Foden, PhD (Wits)
Dr David Grémillet, PhD (Kiel)
Dr Azwianewi Makhado, PhD (Cape Town)
Dr Alistair McInnes, PhD (Cape Town)
Dr 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 Steve Boyes, PhD (KwaZulu-Natal)
Dr Callan Cohen, (PhD, Cape Town
Dr Timotheé Cook, PhD (La Rochelle)
Dr Richard Dean, PhD (Cape Town)
Dr Claire Doutrelant, PhD (Paris)
Dr Robert Flood (PhD, City University, London)
Dr Gabriel Jamie, PhD (Cambridge)
Dr Andrew Jenkins, PhD (Cape Town)
Dr Genevieve Jones, PhD (Cape Town)
Dr Grant Joseph, PhD (Cape Town)
Dr Alan Lee, PhD (Manchester Metropolitan)
Dr Ian Little, PhD (Cape Town)
Dr Kristi Maciejewski, PhD (NMU)
Dr Rowan Martin, PhD (Sheffield)
Dr Martim Melo, PhD (Edinburgh)
Dr Antoni Milewski, PhD (Murdoch)
Michael Mills, MSc (Cape Town)
Prof. Sue Milton, PhD (Cape Town)
Dr René Navarro, PhD (Cape Town) Aug-Dec
Adj. Prof. Lorien Pichegru, PhD (Strasbourg)
Dr Sebataolo Rahlao, PhD (Cape Town)
Dr Yan Ropert-Coudert (PhD, NIPR, Tokyo, Japan)
Dr Jessica Shaw, PhD (Cape Town)
Dr Richard Sherley, PhD (Cape Town)
Dr Antje Steinfurth, PhD (Kiel)

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

Post-doctoral fellows

Dr Pietro D'Amelio, PhD (Munich) (Jan-Mar)
Dr Anthony Lowney, PhD (UCT)
Dr Susan Miller, DPhil (TUT)
Dr Chima Nwaogu, PhD (Groningen & St Andrews) (Jan-Apr)
Dr Jessica van der Wal, PhD (St Andrews)

Support Staff

Manager, DSI-NRF CoE

Dr Susan Miller, DPhil (TUT)

Principal Technical Officer

Gonzalo Aguilar

Information System Specialist

Michael Brooks

Administrative Assistants

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

Niven Library

Librarian: Janine Dunlop, MIT (Lib Sci) (Pretoria)

Project Assistants

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

Ad hoc Research Assistants

James Crossley, Felicity Ellmore, Yi-Ting Ho, Sally Hofmeyr, Justin Jacobs, Brishan Kalyan, Barbara le Roux, Melissa Rankin, Dominic Rollinson, Natasha Shilubane, Ross Soller, Kyle Walker, Vincent Ward

Students

Doctoral

Emmanuel Adekola, MSc (Jos, Nigeria)
Timothy Aikins Khan, MPhil (Ghana)
Christiaan Brink, MSc (Cape Town)
Daniël Cloete, MSc (Cape Town)
Robin Colyn, MTech (CPUT)
Christie Craig, MSc (Cape Town)
Carla du Toit, BSc (Hons) (Cape Town)
Selena Flores, BSc (San Diego)
David Lloyd-Jones, BSc (Hons) (Canterbury)
Samantha McCarren, BSc (Hons) (Cape Town)
Kyle-Mark Middleton, BSc (Hons) (Pretoria)
Angela Moreras, MSc (Bielefeld)
Rebecca Muller, MSc (Cape Town)
Benjamin Murphy. MSc (Exeter)
Carina Nebel, MSc (Vienna)
Olufemi Olubodun, MSc (Ibadan)
Kailen Padayachee, BTech (TUT)
Nicholas Pattinson, MSc (NMU)
Vonica Perold, MSc (Pretoria)
Stefan Schoombie, MSc (Cape Town)
Kim Stevens, BSc (Hons) (Cape Town)
Miqkayla Stofberg, BSc (Hons) (Cape Town)

MSc by dissertation

Temitope Abisoye, BSc (Hons) (Akure)
Farisayi Dakwa, BSc (Hons) (NUST)
Monique du Plessis, BSc (Hons) (Stellenbosch)
Campbell Fleming, BSc (Hons) (Cape Town)
Nosipho Gumede, BSc (Hons) (UNISA)
Carrie Hickman, BSc (Hons) (Open University)
Jess Lund, BSc (Hons) (Cape Town)
Kyle Maclean, BSc (Hons) (Cape Town)
Abigail Ramudzuli, BSc (Hons) (Limpopo)
Taylyn Risi, BSc (Hons) (Cape Town)
Sanjo Rose, BSc (Hons) Cape Town)
Emily Spencer, BSc (Hons) (Cape Town)
Michelle Vrettos, BSc (Hons) (Cape Town)

Masters in Conservation Biology 2021/22

Candice Denner, BSc (Stellenbosch)
Jane Doherty, BVetSci (Onderstepoort)
Nicola du Plessis, BSc (Stellenbosch)
Sara Forsberg, BSc (Norwegian University of Life Sciences)
Ricardo Guta, BSc (Lurio, Mozambique)
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)

Masters in Conservation Biology 2020/21

Jessica Burnette, MPub Admin (Texas)
Hannah Edwards, BSc (Melbourne)
Rowan Hickman, BSc (Hons) (Bangor)
Varalika Jain, BSc (Imperial College, London)
Tamar Kendon, BSc (Hons) (Pretoria)
Eliupendo Laltaika, BSc (Mweka)
Merlyn Nkomo, BSc (Hons) (NUST)
Jonathan Plaistowe, BSc (Hons) (Cape Town)
Imthiaz Sheik Abbass, BSc (Hons) (Mauritius)
Debbie Stanbridge, BSc (Hons) (Cape Town)
Tom Thacker, MSc (Otago)
Gemma Walker, BSc (Hons) (Cape Town)
Debbie Walsh, BSc (University College, London)

BSc Hons

Cameron Blair, Rion Cuthill, Matthew Kennedy, Kagiso Nhlapo, Mila Truter

Externally registered students

Doctoral:

Cambridge –Tanmay Dixit
Helsinki – Teresa Abaurrea
Montpellier – André Ferreira, Aloïs Robert, Nicolas Silva
NMU – Danielle Keys, Katharina Reusch, Zanri Strydom
Porto – Rita Fortuna
Pretoria – Shannon Conradie, Marc Freeman, Ryno Kemp, Celiwe Ngcamphalala
UCT –Edmund Rodseth (MCB), Jessleena Suri (Stats)
Western Australia – Camilla Soravia
Wits – Geethen Singh

MSc/MPhil by dissertation:

Cambridge –Mairenn Collins Attwood
Porto - Marta Marmelo, Lucas Pacheco
Montpellier – Benjamin Dupuis
NMU – Shamiso Banda, Catherine Currin, Lyle de Menezes, Praxedes Rukuni, Victoria Stockdale
Pretoria – Otto Makola

BTech

TUT – Lesedi Moagi

CoE research and education highlights

- We conducted 18 research projects during 2021.
- The FIAO CoE supported 22 PhD and 43 MSc students, and four Postdoctoral Fellows.
- 136 papers were published in peer-reviewed journals, including 46 papers in journals with ISI impact factor ratings ≥3.5.
- 53 popular articles and one book were published.
- CoE members served on the editorial boards of 32 scientific journals and reviewed 49 papers for 33 peer-reviewed journals.
- Sadly, 2022 will be the last year of CoE grant funding

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

Eighteen ongoing research projects were supported in 2021. The Fitz CoE continued to exceed its publication target with 136 papers published in peer-reviewed journals in 2021, including 46 papers in journals with ISI impact factor ratings ≥3.5. One field guide and 53 popular articles were also published.

Dr Robert Thomson will be promoted to Associate Professor from January 2022, which is well deserved recognition of his hard work and dedication to research and teaching within the FIAO CoE and the broader Biological Sciences Department.

Dr Chima Nwaogu was appointed as a Junior Research Fellow using funds from an award to the FIAO from the Carnegie-DEAL (Developing Emerging Academic Leaders) Programme. He is setting up an independent research programme in Zambia on life-history evolution in Afrotropical birds, with a particular emphasis on understanding timing of breeding and how this may respond to climate change in an African context.

Education and training

During 2021, the Fitz CoE supported 22 PhD and 43 MSc students. Four postdoctoral fellows were registered. The Centre graduated 14 students during 2021 (2 PhD, 3 MSc by dissertation, 9 MSc Conservation Biology).

MSc student Jaimie Whyte was selected to represent the "Youth For MPAs" at the IUCN World Conservation Conference in September 2021.

Conservation Biology MSc student Merlyn Nkomo was awarded a Best Social Media Science Communication Award by the British Ornithological Union.

PhD student Christiaan Brink was awarded the best student paper in *Ostrich* in 2020 for his article titled: Potential release sites and strategies for the Bearded Vulture *Gypaetus barbatus* reintroduction in South Africa.

PhD graduate Amanda Bourne won the Purcell Prize for the best Zoology dissertation at UCT in 2020 for her thesis which explored the impacts of climate change on the behaviour, breeding success and physiology of Southern Pied Babblers.

Collaboration and service rendering

The Fitz conducted a broad range of close collaborative working relationships with more than 100 scientific peers and a variety of conservation NGOs and governmental organisations both nationally and internationally.

We continue to build much-needed African capacity in the broad arena of biodiversity conservation. Although few visits by research and conservation partners were possible during 2021, exposure to the broader community was greatly enhanced by the proliferation of webinars during the pandemic.

Fitz CoE members served on the editorial boards of 32 scientific journals and as members of 99 membership and advisory fora during 2021. They served the broader scientific community by participating on scientific steering committees and working groups, by reviewing project proposals for science funding agencies, and by reviewing 49 papers for 33 peer-reviewed international and local journals during 2021.

Information brokerage

Many conferences went ahead in 2021 in either virtual or hybrid formats, allowing a renewal of many outreach activities by CoE members to partner organisations and interested parties during 2021. CoE staff and students presented research virtually at ten international and five local conferences during 2021 including another successful Learn About Birds (LAB) virtual conference co-hosted by the FitzPatrick with Birdlife South Africa.

PhD students Oluwadunsin Adekola, Marc Freeman, Kailen Padayachee and Nick Pattinson presented their work at the LAB Conference, Andrew McKecknie gave a talk and Susie Cunningham presented a plenary lecture. Kailen was awarded the best PhD talk of the conference.

Claire Spottiswoode gave the Witherby Lecture at the British Trust for Ornithology Annual Conference and a plenary lecture at the International Congress of Zoology.

At the second virtual BirdLife South Africa African Bird Fair in July 2021, Peter Ryan gave a talk in the opening ceremony and eight students, one postdoc and one academic presented virtual talks to make up a 90-minute FIAO CoE session.

Four CoE students presented at the virtual annual Biological Sciences postgraduate research day on 30 November 2021. Ben Murphy and Jaimie Whyte were awarded prizes. Three Honours students based at the FIAO also presented, with Cameron Blair winning a prize.

Peter Ryan and Susie Cunningham also presented in the weekly Leadership for Conservation in Africa lecture series.

The continued disruption to public gatherings during much of 2021 meant that continued emphasis was placed on distributing research findings through press releases, which were submitted to and distributed by the UCT Communications and Development Department, the Science Faculty and posted on the FIAO CoE's website and Facebook pages. Some of these press releases included a study exploring the impacts of high temperatures on Rockjumper chicks in South Africa published in the *Journal of Avian Biology*, research into the importance of Sociable Weaver colonies to the surrounding animal community, published in the *Journal of Animal Ecology*, a study on illegal dumping of plastic bottles by ships at sea that wash up on South Africa's beaches, published in *Environmental Pollution*, research linking sunbird pollination with diversity of Erica flowers in the fynbos, published in *Functional Ecology*, and a study on the diet of two vulnerable penguin species that breed at sub-Antarctic Marion Island, published in the *African Journal of Marine Science*.

Research highlights

An article titled 'New study suggests falcons have natural 'eye makeup' to improve hunting ability' about MSc student Michelle Vrettos and Arjun Amar's work featured in UCT's Science Faculty's newsletter, *Science Matters*.

Peter Ryan and Ben Dilley contributed to a paper on novel persistent organic pollutants (POPs) in seabirds that was published in *Environmental Monitoring and Contaminants Research*. The presence of high concentrations of UV-238 in Blue Petrels sampled on Marion Island provides compelling evidence that plastic is responsible for the long-distance transport of this POP, because the Blue Petrel seldom ventures north of the Antarctic Polar Front. This finding is crucial to have this compound banned under the Stockholm Convention.

Several Fitz CoE members contributed to a study published in *Conservation Letters* that identified a foraging hotspot for seabirds in the northeast Atlantic Ocean. This area is set to be proclaimed a marine protected area by the European Union.

Winding down the CoE

As one of the original six CoEs, the third 5-year cycle of DST-NRF support came to an end in 2019. A three-year extension was granted, however, at reduced levels of 75% funding in 2020, 50% in 2021 and 25% in 2022. Therefore, no new students were recruited with CoE bursaries in 2021 and only one new MSc student was awarded running costs. 2022 will be the final year of CoE funding for the Fitz.

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.

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 would 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 (prospecting and laying strategies), which have received little attention to date. Redstarts are the only regular cuckoo host that breeds in cavities, which makes it difficult for female cuckoos to lay eggs and for their newly-hatched chicks to evict host eggs/chicks.

Claire Spottiswoode's team works on a variety of brood-parasitic systems in Zambia, focussing 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,

PhD student Angela Moreras is studying whether variation in Common Redstart nest characteristics can explain the probability of a redstart nest being successfully parasitised. The larger Common Cuckoo eggs often are laid outside the redstart nest cup (left top and bottom) where they will not be incubated. Successful cuckoo eggs need to be in the nest cup (right and bottom left; Photos: Robert Thomson).

A member of the Zambia brood parasite field research team, Silky Hamama, using an endoscope to check a Little Bee-eater nest burrow for brood-parasitic eggs or chicks of Greater Honeyguides. Little Bee-eaters typically excavate their tunnels in the roofs of Aardvark burrows (Photo: Jess Lund).

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 Michael Sorenson, 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. The remarkable adaptation that we are investigating is their blue eggs, highly unusual in piciform birds, that broadly mimic those of their hosts. Moreover, up to three honeybird chicks are raised in the same host nest, despite killing host young with their bill hooks. How honeybirds escape being killed by their nestmates remains an intriguing mystery.

Activities in 2021

- The field season in Finland went ahead with U.Helsinki PhD student Teresa Abaurrea investigating whether cuckoo chicks use carotenoid-based signals to manipulate their foster parents. Despite high nest predation rates and low overall cuckoo parasitism rates, the season was a success. Unfortunately, PhD student Angela Moreras was still unable to get to the field due to COVID-19 travel restrictions but had a busy year using the long-term project datasets to explore and test various front-line

A recently-fledged African Cuckoo chick in the miombo woodlands of southern Zambia. Unlike their close relative the Common Cuckoo, African Cuckoos are specialist brood parasites of a single host species, the Fork-tailed Drongo, whose variety of defensive egg "signatures" they closely mimic (Photo: Mairenn Attwood).

host defences and their effectiveness.

- Jess Lund and Mairenn Attwood both began their PhD studies at U.Cambridge, respectively working on honeyguide-host and cuckoo-drongo interactions. They carried out a productive field season during the Zambian dry season in September–November, together with our local field team led by Collins Moya and Silky Hamama.
- Rainy season fieldwork (January–April) was impossible because of COVID restrictions, but the team working on cuckoo finches and their hosts are looking forward to returning in 2022.
- Gabriel Jamie carried out two months of fieldwork establishing a new field site in north-west Zambia as part of his new fellowship project (below).
- As a team we presented a two-week online workshop on "Research Skills in Ecology and Evolution" for over 30 participants consisting of graduate students and staff at Copperbelt University and Livingstone Museum in Zambia.

Highlights

- Angela Moreras, Robert Thomson and several collaborators published a paper in *Behavioral Ecology* exploring front-line defence strategies as an anti-parasite strategy. The paper showed strong redstart preference for small entrance cavity size, which in turn significantly lowered cuckoo brood parasitism risk.
- Tanmay Dixit, Claire Spottiswoode and collaborators published a perspectives paper in *Evolution* on "Why and how to apply Weber's Law to coevolution and mimicry". It argued that Weber's Law of proportional processing (a psychological phenomenon) can lead to counterintuitive predictions about the evolution of mimicry systems, such as host egg mimicry by brood-parasitic birds.
- Eleanor Caves, Claire Spottiswoode and others (including collaborators in Zambia, Lazaro Hamusikili and the late John Colebrook-Robjent) published a paper in *Proceedings of the Royal Society of London B* asking how host eggs deploy defensive adaptations that allow them better to discriminate their own eggs from parasitic eggs.
- Gabriel Jamie, Silky Hamama, Collins Moya, Rebecca Kilner and Claire Spottiswoode published a paper in *Behavioral Ecology* exploring the factors limiting the colonisation of new hosts, and thus speciation, in brood-parasitic indigobirds and whydahs. It showed that a key hurdle in colonizing new hosts is obtaining the right amount rather than the right type of food from host parents. This highlights the importance of chick mimicry in parasitic success, likely explaining why successful colonisations tend to be of hosts closely related to the ancestral one.
- Several Fitz members were part of a

A recently fledged Common Cuckoo chick on the lichen covered pine forest floor in northern Finland. Young cuckoos are often grounded for the first days after fledging, but the host redstarts continue to feed them and after a day or two they fly to the forest canopy (Photo: Robert Thomson).

collaborative team, led by Stephanie McClelland and Steve Portugal from Royal Holloway (University of London), who published a paper in *Proceedings of the Royal Society of London B* on how embryonic "exercise" may help prepare brood-parasitic chicks for their murderous first days of life.

- MSc student Jess Lund (UCT) was awarded a Distinction for her MSc entitled "Coevolutionary causes and consequences of high-fidelity mimicry by a specialist brood parasite".
- Gabriel Jamie was awarded the Society for the Study of Evolution's Presidents' Award for his 2020 paper in *Evolution* showing how indigobirds and whydahs mimic the chicks of their specialist host species visually, vocally and with respect to their begging movements. This paper shed light on how imprinting and mimicry have promoted sympatric speciation in indigobirds and whydahs.
- Gabriel was also awarded a Leverhulme Early Career Fellowship (based at University of Cambridge), to allow him to carry out a new project building on his previous work on brood parasitism and the evolution of polymorphisms. In his new project, Gabriel will use a mixture of fieldwork and genomics to understand the incredible diversity of egg patterns and colours found across the Cisticolidae (cisticolas and prinias), and how such polymorphisms have persisted across this African radiation.
- The beautiful mimicry shown by nestling Pin-tailed Whydahs of their Common Waxbill hosts is showcased in David Attenborough's "Life in Colour" series on the BBC and Netflix. Gabriel Jamie acted as scientific consultant during the filming and contributed sound recordings.

Key co-supporters

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

Research team 2021

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

Students: Teresa Abaurrea (PhD, U. Helsinki); Tanmay Dixit (PhD, Cambridge); Angela Moreras (PhD, UCT); Mairenn Attwood (PhD, Cambridge); Jess Lund (MSc, UCT and PhD, Cambridge); Rowan Hickman (CB MSc, UCT).

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

The evolution, ecology and conservation of honeyguide-human mutualism

This project focuses on a unique mutualism: the foraging partnership between Greater Honeyguides *Indicator indicator* and human honey-hunters whom 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 and Keith Begg of the Niassa Carnivore Project. A key focus to date has been investigating reciprocal communication between the two parties: not only do honeyguides signal to humans, but in many different cultures humans signal back to honeyguides, giving special calls to attract honeyguides and maintain their attention while following them. 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, 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.

Activities in 2021

- Fieldwork was limited in 2021 owing to COVID-19, but David Lloyd-Jones was able to make three short visits to Niassa to support our field team of honey-hunter colleagues, who continued to collect excellent data on their interactions with honeyguides.
- We hosted a two-day online workshop on "Human-Wildlife Mutualisms", involving 40 colleagues from 14 countries, including biologists, anthropologists, historians, conservation practitioners and honey-hunters.
- CB MSc student Eliupendo Alaitetei Laltaika completed his MSc on honeyguide-human interactions in four cultures in northern Tanzania. We welcome Laltaika as a PhD student in 2022.
- Honours student Rion Cuthill studied the effects of honeyguide-human mutualism on fire ecology, co-supervised by Prof. Sally Archibald. Rion will continue to work with the team in 2022.
- Honours student Cameron Blair completed his research project on the developmental origins of the Greater Honeyguide's guiding call, co-supervised by Jessica van der Wal. Cameron will

The 'Projecto Sego' team of honey-hunters with the honey-hunting 'capulana' produced by the Fitz research team, to provide a form of media for honey-hunters to talk to, and hopefully enthuse others in the community about their profession (Photo: David Lloyd-Jones).

join the brood parasite coevolution team as an MSc student in 2022.

- Our citizen science project, Honeyguiding.me, managed by Jessica van der Wal, 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 also our website: AfricanHoneyguides.com).
- We established a new field site at Honeywood Farm near Grootvadersbosch Forest in the Western Cape, South Africa, allowing us to address some of our honeyguide research objectives closer to base.

Highlights

- We submitted two collaborative review papers arising from our "Human-Wildlife Mutualisms" workshop, on the ecology and evolution of human-wildlife cooperation, and on its safeguarding; these are currently under review.
- Eliupendo Laltaika (MSc), Rion Cuthill (Honours) and Cameron Blair (Honours) all received Distinctions for their research dissertations.
- Jessica van der Wal and Claire Spottiswoode presented their research findings at the "Interspecies Conversations" workshop, an interdisciplinary meeting involving biologists, anthropologists, computer scientists, linguists, artists and others.
- Claire Spottiswoode presented a plenary talk on the honeyguide team's research at the International Congress of Zoology.
- Jessica van der Wal collaborated with Cape Town artist Jane Solomon to produce a 'capulana' (a traditional Mozambican sarong) depicting a honey-hunting scene in Niassa, to provide a form of media for honey-hunters to talk to, and hopefully enthuse others in the village about their profession. We thank the Eric Hosking Trust for their support of this initiative.

Impact of the project

This project involves rural communities in understanding a unique human-animal relationship. We hope to further our understanding of how mutualisms evolve, and specifically how learnt traits mediating mutualisms may coevolve. 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.

Key co-supporters

European Research Council; 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 2021

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

Students: David Lloyd-Jones (MSc, UCT); Eliupendo Alaitetei Laltaika (CB MSc, UCT); Rion Cuthill (Honours, UCT); Cameron Blair (Honours, UCT).

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

Cooperation and population dynamics in the Sociable Weaver

The elaborate social system and cooperative behaviour of Sociable Weavers *Philetairus socius* make this Kalahari endemic bird an ideal species to study cooperation. Our long-term project at Benfontein Reserve focuses on cooperative breeding, nest-building and vigilance against predators to understand the fitness benefits and costs of cooperating. Our long-term data also provide insights into how social and environmental variation influence reproduction and survival, and how this ultimately influences population trends. A recent fire at the study site in 2021 inadvertently led to a new line of research on the social and demographic effects of natural catastrophes.

The Sociable Weaver project, led by Rita Covas and Claire Doutrelant, suffered a major blow at the end of September 2021 when a devastating fire destroyed many of the long-term study colonies. The unusual fire burned for days, fuelled by large volumes of dry biomass resulting from exceptional rains the previous summer. Despite the best efforts of the field team to fight the fire, most Sociable Weaver colonies at Benfontein burned. Fortunately, eight colonies survived to continue our study of cooperation and population dynamics.

Thanks to the impressive commitment of the field team, we were able to document in detail the effects of the fire on the numbers of birds in each colony. We observed a sudden marked increase in size of the surviving colonies associated with increased levels of aggression, and we continue to monitor how the disruption affected colony composition, reproduction, etc. This opens a sad but interesting line of investigation as natural catastrophes are increasing under ongoing climate change.

In spite of the fire, 2021 was a good year for the Sociable Weaver project. Two studies were published, one led by Rita Fortuna and one by Pietro D'Amelio showing how weather, nest predators and social factors interact to determine maternal investment and reproductive output, respectively. André Ferreira concluded his PhD thesis on social preferences, kinship and helping behaviour, and three new MSc projects by Lucas Pacheco, Marta Marmelo and Benjamin Dupuis started to provide insights into roosting associations, vigilance behaviour and the demographic effects of predator exclusion. These projects are part of the first steps that we are taking towards the objectives of our European Research Commission (ERC) grant on understanding the role of partner choice for the evolution and stability of cooperation.

Activities in 2021

- The 2020/21 breeding season was unusually short, ending in mid-February, probably due to very high rainfall in the early summer. This led to unusually lush grass growth, which appears to have been too much for the semi-desert Sociable Weavers.
- After the pandemic-imposed break, annual captures of all birds in our colonies resumed with a total of 520 birds caught and ringed.
- Thanks to European and French grants, we conducted fieldwork throughout the year for the first time, collecting data on nest building behaviour and on feeding and roosting associations, which will lead to a better understanding of social structure and benefits of group membership.
- Detailed data on nest building, which forms part of Nicolas Silva's PhD, is allowing the quantification of possible benefits and costs for the individuals involved.
- 2021 was a year of intensive data analysis and manuscript preparation, as André Ferreira and Rita Fortuna approached the end of their PhDs, and Pietro D'Amelio concluded analyses on our long-term data. Four manuscripts were published or accepted for publication.
- Advances in video analysis led by Liliana Silva (CIBIO, U. Porto) now allows provisioning data to be analysed semi-automatically, and trials of fully automated analyses are promising, currently at >70% accuracy.

A devastating fire at Benfontein reserve in September 2021 burned down most of the Sociable Weaver colonies in our long-term study area. Franck Théron, who has worked on the project since 2013, stands next to a scorched *Vachellia erioloba* that used to house 45 pairs of Sociable Weavers (Photo: Tanguy Deville).

- Pietro D'Amelio started trials with miniature on-board microphones with the aim of recording individual vocalisations in cooperative groups.

Highlights:

- André Ferreira concluded his PhD entitled *Social preferences, kinship and helping behaviour in a colonial cooperatively breeding bird* with an outstanding defence.
- Rita Fortuna published a paper in the *Journal of Animal Ecology* using our long-term data to investigate maternal allocation in relation to weather, predation and social factors. Rita had another paper accepted in *Behavioral Ecology* on begging behaviour and the feeding responses of parents and helpers.
- Pietro D'Amelio further demonstrated the value of long-term and experimental data with a publication in *Ecology Letters* reporting climatic and nest-predation effects on reproductive output. The study revealed that hot, dry weather was a major driver of nestling mortality, and that the presence of helpers at the nest, although positive, did not mitigate the effects of adverse weather. It seems that cooperative breeding might have a limited capacity to mitigate extreme weather effects.
- A study that used oxidative stress to assess the physiological costs of helping, and how that influences helping decisions, was accepted for publication in *Behavioral Ecology*.

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 in relation to environmental change and provide a baseline against which to study the extreme environmental events that increased in frequency under climate change.

Key co-supporters

European Research Council (ERC); French Research Agency (ANR); DSI-NRF CoE grant; Portuguese Foundation for Science and Technology (FCT); Marie Curie Fellowships (EU).

Research team 2021

Dr Rita Covas (FIAO, UCT and CIBIO, U. Porto)
Dr Claire Doutrelant (FIAO, UCT and CNRS, France)
Dr Fanny Rybak (U. Paris-Sud, France)
Dr Pietro D'Amelio (FIAO)

Students: André Ferreira (PhD, Montpellier); Rita Fortuna (PhD, Porto); Nicolas Silva (PhD, Montpellier); Benjamin Dupuis (MSc, Montpellier); Lucas Pacheco, (MSc, Porto); Marta Marmelo (MSc, Porto).

Research Assistants: Franck Théron, Liliana Silva, Annie Basson, Tanguy Deville, Bronwyn Dunlop, Stuart Dunlop, Andrew Elliot, Angelique Lazarus, Tshianeo Ndou, Natasha Prindal, Deborah Walsh.

Pied Babblers and Fork-tailed Drongos

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 evolutionary ecology of Pied Babblers, providing unique insight into conflict and cooperation in societies, life-history strategies and mating systems. In 2006, Amanda began investigating community interactions between Fork-tailed Drongos *Dicrurus adsimilis*, babblers and other species. Tom Flower joined and greatly expanded the drongo research in 2008, establishing the Drongo Project to study the drongos' use of false alarm calls to steal food from other animals. Recently, Amanda and Tom have collaborated with Susie Cunningham and Claire Spottiswoode to explore how increasing temperatures will affect the demography of these species in marginal desert environments.

The causes of conflict and cooperation in group-living societies

The Pied Babbler research project investigates the costs and benefits of cooperation, and the effect of climate change impacts 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 a number of high-profile papers published from her PhD chapters, including publications in *Ecology Letters* and *Proceedings of the Royal Society Series B.* We 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. PhD student Camilla Soravia has been using thermal cameras and cognitive tasks to understand the effect of heat stress on cognition and has now completed her fieldwork.

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. We are hopeful that with the easing of border restrictions, more researchers can return to the babbler study site, at which time we will need to invest a lot of work to return the population to the level of habituation and ringing that it was at prior to the pandemic.

How interactions between species shape animal behaviour

The Fork-tailed Drongo project explores how interactions with other species can shape the evolution of behaviour. Over 40 pairs of individually colour-banded drongos have been habituated. Current research considers the cognitive mechanisms that enable drongos to produce false alarm calls and adjust the calls they use depending upon feedback from the target species. Since 2014, we also have studied the impact of climate change on bird persistence in

hot desert environments through impacts on foraging behaviour and offspring provisioning. PhD student Ben Murphy is studying how drongos adjust their behaviour to reduce the impact of high temperatures on reproductive success, including through offspring shading, foraging tactics and crepuscular/nocturnal activity. Such behaviour change may compensate for the costs of missed opportunities when temperatures are high, enabling drongos to adapt to climate change. However, it remains to be determined whether the behavioural adjustments are sufficient to enable drongos to persist in their current range.

Activities in 2021

- PhD student Camilla Soravia completed her fieldwork on heat stress and cognition.
- At the end of 2021, field assistants Amy Hunter and Samantha Wagstaff were able to assess and collect data on the Pied Babbler population, after a long period when the population could not be observed due to the COVID pandemic.
- PhD student Ben Murphy completed his fieldwork and is presently collating his data.
- BTech student Lesedi Moagi, working with Amanda Bourne, Andrew McKechnie, Ray Jansen (TUT) and Andre Ganswindt (UP) completed the labwork and analyses for her project on faecal corticosterone metabolites in babblers, showing that these increase with maximum daily temperatures above 38°C, but return to baseline levels the following day, suggesting that hot days represent acute stressors for these birds.

Highlights:

- Two reviews were published: one on Pied Babbler research, first-authored by Amanda Ridley in *Advances in the Study of Behaviour*, and the other on heat stress impacts on cognition, first-authored by Camilla Soravia in *WIREs Climate Change*.
- Several Pied babbler papers were published from Amanda Bourne's PhD research, including papers in *Ecology Letters, Proceedings of the Royal Society B, Frontiers in Ecology and Evolution, Ibis, Conservation Physiology,* and *Behavioral Ecology.*
- Pied Babbler and Fork-tailed Drongo research was presented at several national and international conferences, including the Australasian Ornithological Conference and the Association for the Study of Animal Behaviour conference. Amanda Ridley gave invited talks in the UK and the US.
- Amanda Ridley and colleagues Alex Thornton and Ben Ashton were awarded a three-year Australian Research Council grant to conduct further research on the relationship between heat stress and cognition in Pied Babblers.
- Tom Flower joined the Executive Board of the Wild Bird Trust of British Columbia.

A Southern Pied Babbler undergoing an associative learning test in the wild. In this test, the babbler needs to learn an association between the shade of colour and a food reward (only one shade contains a food reward) (Photo: Nicholas Pattinson).

For more details on the collaborative work between the Pied Babbler and Fork-tailed Drongo Projects and the Hot Birds Research Project, see page 47.

Key co-supporters

DSI-NRF CoE grant; Australian Research Council.

Research team 2021

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

Students: Ben Murphy (PhD, UCT); Camilla Soravia (PhD, UWA); Lesedi Moagi (BTech, TUT).

Research Assistants: Amy Hunter, Samantha Wagstaff.

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

Pygmy Falcons *Polihierax semitorquatus* are the most controversial user of the weaver colonies. They never construct their own nests, depending entirely on weaver colonies, which is a unique obligate nesting association. Pygmy Falcons also, albeit rarely, prey on weaver nestlings and even adults, suggesting a semi-parasitic relationship between the species. We study the natural history and ecology of Pygmy Falcons, and assess whether the falcons provide benefits to the weavers.

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

Sunset in Tswalu Kalahari (Photo: Anthony Lowney).

Activities in 2021

- Despite another year of COVID-19 challenges, PhD students Olufemi Olubodun and Timothy Aikins Khan completed their field seasons. Timothy is investigating the costs and benefits of hosting Sociable Weaver nests to Camelthorn *Vachellia erioloba* and Shepherd's Trees *Boscia albitrunca*. He collected most of the samples for soil and plant analyses. Olufemi is studying various aspects of the life history of Pygmy Falcons and monitored the breeding success and group composition of the falcon population.
- This was the 11th field season at Tswalu Kalahari Reserve. The site experienced fairly good summer rains, but less than the previous season, resulting in lower breeding activity by Sociable Weavers and Pygmy Falcons. We followed 33 Pygmy Falcon pairs and ringed 47 fledglings.
- Olufemi and Anthony Lowney obtained additional GPS tracking data from seven Pygmy Falcons from four breeding pairs. Olufemi will use these data to investigate their territoriality and foraging movements.

Timothy and Olufemi at a partially collapsed Sociable Weaver nest on a Shepherd's Tree (Photo: Jane Doherty).

- 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.

Highlights:

- Anthony Lowney and Robert Thomson published a paper in *Journal of Animal Ecology* showing the importance of Sociable Weavers as ecological engineers and the significance of their colonies in structuring the surrounding animal community year-round. The study highlights that Sociable Weaver colonies create centres of animal activity in the Kalahari.
- The project hosted the Conservation Biology Masters programme field course. The 14 CB students collected data on sub-canopy vegetation cover around Shepherd's Trees with and without Sociable Weaver colonies. These data will feed into Timothy Aikins Khan's PhD.
- Timothy and Olufemi gave multiple talks on their studies. Both presented talks at the African Bird Fair 2021. Timothy also presented to the Somerset West Bird Club and Olufemi gave a poster presentation on the breeding biology of the Pygmy Falcon at the Ecology Across Borders 2021 conference.

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 that enhances the experience of visitors to landscapes within the distribution of the Sociable Weaver.

Key co-supporters

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

Research team 2021

Dr Robert Thomson (FIAO, UCT)
Dr Anthony Lowney (FIAO PostDoc, UCT)
Dr Diana Bolopo (FIAO, UCT)
Prof. Michael Cramer (Biological Sciences, UCT)
Dr Mariette Marais (ARC – Plant Protection Research Institute, Pretoria)
Dr Bryan Maritz (UWC)
KEEP team (led by Prof. Andrea Fuller, and Prof Graham Alexander, both WITS)

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

Understanding colour polymorphism in birds

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

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

The idea that pairs consisting of the two morphs complement each other is termed the 'complementarity' hypothesis. Support for this hypothesis comes from prey provisioning behaviour. Nest camera data shows that mixed-morph pairs provide food more consistently to the nest than like-morph pairs. This indicates that the two morphs forage under different ambient light levels and are expanding their foraging niche as a pair. This research was published in *Behavioral Ecology*, and forms part of Carina Nebel's PhD thesis which was awarded in 2021.

Another aspect of Carina's PhD has been to extend our understanding of this system through population modelling. Working with Dylan Childs from the University of Sheffield, through a Newton grant from The Royal Society, Carina has developed an Individual-Based Model (IBM) to better understand the different components of the system, and to explore whether the complementarity hypothesis could operate to maintain the stable polymorphism seen in our study population.

Additional research has focused on the genetics behind plumage polymorphism. Using a multi-generational pedigree, we have recently established that the most likely inheritance mechanism in this system is one where the dark allele is dominant. In many vertebrates, discrete colour polymorphisms have been linked to the MC1R gene, which is involved in the regulation of melanin production. However, we have established that this is not the case for Black Sparrowhawks, and several other potential candidate genes also have been excluded. The differences in melanin production between the two morphs appears to be associated with different regulation of key genes involved in melanin production. Interestingly, variation in phaeomelanic plumage in juveniles appears to be regulated by expression differences in the same genes. We are now testing for differences in telomere dynamics between the two adult morphs to determine if there are any pleiotropic effects of morph. We also quantified haemosporidian blood parasite prevalence and intensity from blood samples using qPCR, to supplement previous data based on microscopy screening of blood slides.

We have also continued to use web-sourced photographs to better understand the distribution of colour polymorphisms across different species' ranges. In collaboration with Dr

Chris Briggs at Colgate University, USA, and Dr Chevonne Reynolds at Wits University, we have collected data on the morph distribution of Red-tailed Hawks and Ferruginous Hawks across their North American range, these data will be combined with previously analysed data on Swainson's Hawks to examine for consistency in the association between morphs distribution and climatic variables.

Activities in 2021

- In 2021, we ringed 50 Black Sparrowhawk nestlings from 24 nests. Ringing nestlings is an integral part of the long-term monitoring and research of this population. Unfortunately, due to cuts in the CoE funding, 2021 will be the last year of nest monitoring on this project.
- PhD student Carina Nebel was awarded her PhD for her thesis entitled 'A mechanistic approach to understanding the colour polymorphism in Black Sparrowhawks (*Accipiter melanoleucus*)'.
- Post-doc Chima Nwaogu analysed the influence of weather conditions on timing of egg-laying and breeding success on Black Sparrowhawk morphs. His results show that interactions between sex, timing of breeding and rainfall may underlie the maintenance of colour polymorphism and the increasing frequency of light morph Black Sparrowhawks in Cape Town.

Highlights

- Carina Nebel published two of her PhD chapters. The first paper, published in *Scientific Reports* showed that the offspring of mixed morphs did not appear to invest more resources into their immune function, and this, therefore, was unlikely to be the mechanism behind higher survival rates of these offspring. The second paper, published in the *Journal of Zoology*, revealed that our multigenerational pedigrees are incompatible with a one-locus two-allele system, where the light allele is dominant (as previously suspected), but are consistent with a scenario where the dark allele is dominant instead.
- Former Honours student Samantha McCarren published her findings on the blood parasite *Haemoproteus nisi* infections in Black Sparrowhawks in the *Journal of Ornithology*. She related infection intensity to breeding performance and fitness, and found that blood parasites are not associated with selective pressure in the species.

In 2021, Juvenile Black Sparrowhawks were monitored after fledging and a photographic inventory was created for 38 of the 50 ringed juveniles. These photographs will be useful for future analyses of colour polymorphism starting at the juvenile stage (Photos: Kyle Walker).

Impact of the project

This project adds to our understanding of the maintenance of genetic diversity in populations. It provides the first empirical evidence for the light level hypothesis for the maintenance of colour polymorphism in birds that is now experimentally tested.

Key co-supporters

DSI-NRF CoE grant; UCT Visiting Scholars Fund; Royal Society International Exchange Grant.

Research team 2021

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

Students: Carina Nebel (PhD, UCT); Edmund Rodseth (PhD, MCB, UCT).

Research Assistants: Rebecca Muller, Kyle Walker.

Volunteers: Margaret MacIver, Jacques Giliomee, Marlene Hofmeyr, Gillian Cowan, Megan Jackson, Robert Daley, Ruben Jenkins-Bate, Ann Koeslag, Michael Lamprecht and Cameron Blair.

Bird pollination in the Cape Floristic Region

Do anthropogenic effects change the ecosystem services provided by nectarivorous birds? The Cape Floristic Region hosts over 300 plant species that depend on only eight species of nectar-specialist sunbirds and sugarbirds. This unusually asymmetrical mutualism provides an ideal system to investigate the pivotal role that pollinators play in the evolution and conservation of plants. This project investigates how sunbirds influence flower colour evolution in bird-pollinated ericas, and how supplementary feeding along the urban fringe and ongoing habitat fragmentation are threatening these processes in many parts of the Cape Floristic Region.

The genus *Erica* is one of the most diverse in the fynbos biome, and its many bird-pollinated species are striking for the high levels of flower colour polymorphism. Some *Erica* species have up to five colour morphs yet are pollinated predominantly by just one bird species, the Orange-breasted Sunbird *Anthobaphes violacea*. Former post-doc Anina Coetzee and PhD student Samantha McCarren are investigating the origin and maintenance of these flower colour polymorphisms. Specifically, they are asking what role plant community context and sunbird foraging behaviour play in generating intra-specific flower colour diversity.

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

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

A Malachite Sunbird *Nectarinia famosa* drinking at a supplementary nectar feeder (Photo: Monique du Plessis).

At the border between urban and natural fragments, supplementary feeding of nectar-feeding birds, which is increasing in popularity, may impact sunbird-plant mutualisms. MSc student Monique du Plessis assessed the effect of feeders on sunbirds and bird-pollinated *Erica* species. By taking advantage of the tell-tale sign left when sunbirds probe *Erica* flowers, she was able to assess flower visitation rates at varying distances from nectar feeders in gardens bordering natural areas.

Activities in 2021

- Anina Coetzee took up a teaching position at Nelson Mandela University, George campus. She is starting new projects on bird-pollination systems in the southern Cape, in collaboration with Dr Colleen Seymour.
- PhD student Samantha McCarren recorded flower reflectance of a diversity of *Erica* species, and found that ultra-violet signals are absent or rare in ericas pollinated by short-proboscid insects, rodents, or wind. It occurs in some bird-pollinated ericas and choice experiments with sunbirds showed that they can learn to discriminate flowers based on their UV reflection. However, sunbirds do not show a preference for UV colouration.
- Monique du Plessis was awarded her MSc degree with Distinction. Her experiment in the Cape Peninsula added supplementary feeders to gardens bordering fynbos veld. This showed that feeders seem to attract some nectarivorous birds away from the natural veld towards gardens. One of the two *Erica* species monitored were visited less often by sunbirds when feeders were present.
- PhD student Daniël Cloete's analyses show that the fynbos specialist endemics, Cape Sugarbird and Orange-breasted Sunbird, are both negatively affected by habitat fragmentation. Their numbers are much reduced in smaller fynbos patches. By contrast, more generalist species such as the Southern *Cinnyris chalybeus* and Greater Double-collared Sunbirds *C. afer*, and Amethyst Sunbirds *Chalcomitra amethystina* are more common in small fragments, and may even benefit because of their flexibility to use resources from the surrounding non-fynbos matrix.

Highlights

- Anina Coetzee published a paper in *Functional Ecology* with Colleen Seymour and Claire Spottiswoode, on a geographic mosaic of flower colours in bird-pollinated ericas in the Cape fynbos. Using fieldwork and visual modelling, Anina showed that in some circumstances, natural selection drives bird-pollinated *Erica* species in different plant communities to mimic one another by converging on the same flower colour, to better attract the sunbirds that pollinate them. However, when the reproductive parts of different species are similar in size, natural selection instead favours colour divergence to avoid receiving pollen from the wrong species. Together these two processes appear to have helped to drive the remarkable diversity in flower colour within and between *Erica* species.
- Anina also published a paper in *Ostrich* with Phoebe Barnard and Anton Pauw, describing the distribution of supplementary nectar-feeding in cities in the Cape Floristic Region.
- Monique du Plessis published a paper in *Global Ecology and Conservation*, together with Colleen Seymour, Claire Spottiswoode and Anina Coetzee, on her interesting results about the effects of supplementary nectar-feeding on birds and plants.
- Samantha McCarren published a paper in *Journal of Pollination Biology* with Anina Coetzee and Jeremy Midgley, on her work on sunbirds' responses to UV signals in flowers.
- Anina and Monique presented their research on supplementary nectar-feeding at the Fynbos Forum conference.

Impact of the project

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

Key co-supporters

Claude Leon Foundation; Biotechnology and Biological Sciences Research Council; SANBI Joan Wrench Scholarship; Harry Crossley GreenMatter Scholarship; Smuts Memorial Postdoc Fellowship.

Research team 2021

Dr Anina Coetzee (FIAO, UCT)
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Dr Phoebe Barnard (FIAO, UCT)
Dr Mark Brown (UKZN)
Prof. Peter Ryan (FIAO, UCT)
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Students: Daniël Cloete (PhD, UCT); Monique du Plessis (MSc, UCT); Samantha McCarren (MSc, UCT)

Why do Afrotropical birds breed when they do?

Breeding seasons are arguably 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 essential to understand 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 food availability for nestlings is the main determinant of breeding seasonality in birds. However, in the tropical and south-temperate zones where much more biodiversity resides, the link between breeding phenology and food abundance is less clear-cut. 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. 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.

In 2021 we started a research project to address this knowledge gap, at our long-term study site in Choma, Zambia. Here there are distinct wet and dry seasons and a species-rich bird community including some species that breed only in either the wet or the dry season, while others breed in both seasons. We are combining field sampling and field experiments with analyses of long-term breeding data from the work of Major John Colebrook-Robjent from 1970–2008, and for many of these species from work by colleagues in the Fitz who have worked here on other topics since 2006 (see https://www.africancuckoos.com/). Additional long-term datasets are available from the South African Nest Record Card scheme which holds breeding records from the 1910s to the 1990s.

This project provides an exciting opportunity to disentangle the components of seasonal

Chima Nwaogu demonstrating how to use of Vernier callipers to our colleague Efte Simanunki in Choma, Zambia (Photo: Silky Hamama).

Chima Nwaogu returning a ringed and sampled Black-Crowned Tchagra *Tchagra senegalensis* nestling to its nest on a Protea tree (Photo: Efte Simanunki).

environmental conditions that drive avian timing of breeding in a tropical 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 2021

- The field season in Zambia went well, with Chima Nwaogu spending three months collecting data from September to December, and Claire Spottiswoode visiting in September–October. Unfortunately, Chima is still unable to return to Cape Town due to visa denial and further delays in issuing an appeal decision on his Critical Skills visa application, but he has had a busy year working remotely.
- UCT and Groningen Nuffic-NRF joint PhD student, Rebecca Muller continues sorting, digitizing, and exploring over 100,000 nest record cards held in the Niven Library for her PhD assessing the impact of climate change on breeding seasonality in Afrotropical birds.
- The Choma research team presented a two-week online workshop on "Research Skills in Ecology & Evolution" for over 30 participants consisting of graduate students and staff at Copperbelt University and Livingstone Museum in Zambia.
- Our local field team at Choma, led by Collins Moya and Silky Hamama, continues to collect data on breeding incidence for several bird species and invertebrate, grass seeds, flower, and fruit abundance in our study plots.

Highlights

- Chima was appointed as a Junior Research Fellow thanks to the Carnegie Developing Emerging Academic Leaders Fellowship awarded to the Fitz.
- Chima and team were awarded the British Eological Society's Ecologists in Africa grant of £9,947 to support field work in Zambia.
- Rebecca Muller was awarded a NRF-FBIP grant for digitising historical nest record cards for birds in South Africa. This grant of R62,000 will support the digitization of the nest record cards at the Fitz for her PhD.
- Chima was awarded the British Ornithological Union Early Career Development Bursary of £2,500 to visit Dr Martijn van de Pol at James Cook University, Australia for six weeks. He will use advanced R packages to build automated analysis programmes to analyse the long-term bird breeding data from Zambia. Chima will also learn how to use GitHub with R for documenting data analyses, version control, and collaborative analyses consistent with open science practices (open data and code).

Key co-supporters

British Ecological Society; British Ornithological Union.

Research team 2021

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

Student: Rebecca Muller (PhD, UCT).

Research assistants: Silky Hamama, Collins Moya, Sylvester Munkonko, Efte Simanunki, and many others.

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. Migrant birds are at greater risk of extinction globally than are 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. As a result, large birds have to adopt 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 little is known about the migratory routes of intra-continental migrant birds in Africa compared to inter-continental migrants. In 2015 Phoebe Barnard recruited Post-doc Dayo Osinubi to start an intra-African migration project to investigate the migratory patterns of selected intra-African migrant birds. The project attempted to use a broad-scale spatial approach to address questions of phylogeography, movement ecology, phenotypic and genetic variation in intra-African migrant birds. The main focus was on Woodland Kingfishers *Halcyon senegalensis*, which have resident populations in central Africa and migrant populations at the northern and southern edges of their range and resident populations in between, with individuals breeding in the south migrating and spending their non-breeding period in the north.

Another migration study led by Gary Allport proposes to find the breeding grounds of the critically endangered Steppe Whimbrel *Numenius [phaeopus] alboaxillaris* by fitting satellite tags onto birds on the non-breeding grounds in Mozambique. Unfortunately, no birds have been seen in Maputo in the last few years, so a search was made for other wintering areas farther north in Mozambique. This was done in conjunction with surveys of coastal birds for this poorly-known region.

Activities in 2021

- PhD student Emmanuel Adekola made good progress with his thesis, publishing one chapter and completing draft papers from two other chapters: one on wing moult in White-chinned Petrels *Procellaria aequinoctialis* and another on Shy/White-capped Albatrosses *Thalassarche cauta/steadi*. He also compared flight feather quality between adult and juvenile Amur Falcons *Falco amurensis* from the large sample of birds collected by David Allan after they were killed by hailstorms in KwaZulu-Natal in March 2019. He will complete his PhD in early 2022.
- Peter Ryan collected moult data from Tristan Albatrosses on Gough Island from March to May 2021 to supplement photographs of breeding birds taken in 2015, 2016 and 2019. By photographing non-breeding birds displaying with raised wings he was able to explore how

the extent of primary and secondary moult varies in relation to age, sex and previous breeding history (especially time since last breeding). A draft manuscript is almost ready for submission.

- Peter also collected additional data on the extent and symmetry of secondary covert moult in a variety of petrel species while on Gough Island.
- Dayo is finalising a manuscript on the migration route of southern African Woodland Kingfishers, based on geolocator tracks of five birds captured as breeders in Limpopo Province of South Africa.
- A paper on genetic and morphological variation in the Woodland Kingfisher has been submitted to *Ostrich*, and a paper on genetic variation in the African Pygmy Kingfisher has been submitted to the *Journal of Ornithology*. Both are collaborations with the National Zoological Gardens, SANBI.
- Taylyn Risi made slow progress with her MSc on wing moult in oystercatchers due to personal circumstances, but she is positive that she will complete her thesis in 2022.
- During November-December 2021, Peter Ryan visited Mozambique to identify possible sites for tagging Steppe Whimbrels. He worked with Evan Trotzuk (African Parks) and Dave Tennant (The Sanctuary) to conduct surveys of coastal birds in the Bazaruto/Vilanculos region. A comprehensive survey of coastal birds in this area is planned for November 2022.

Highlights

- Abigail Ramudzuli was awarded her MSc on the moult patterns of Woodland Kingfishers and the use of stable isotope markers in their flight feathers to determine where migratory birds spend the non-breeding season. She will graduate in 2022.
- Emmanuel's paper on moult in Amur Falcons *Falco amurensis* was published in the *Journal of Ornithology*, and his paper on Cape Gannet moult was published in *Ostrich*.
- Alexis Osborne published a methods paper in *Ostrich* on the use of photographs to score moult in breeding seabirds.
- Dayo's field experience of tagging Woodland Kingfishers with miniature geolocators resulted in a joint symposium on the ethics of biologging to be convened at the 28th International Ornithological Congress in August 2022.

A Steppe Whimbrel takes off alongside three Common Whimbrels at Imhambane, Mozambique (Photo: Peter Ryan).

- One Steppe Whimbrel was photographed at Inhambane during surveys of coastal birds at selected sites along the central Mozambican coast.

Impact of the project

The timing and intensity of moult is thought to be related to stress in bird populations, and monitoring changes in these parameters might provide a useful measure of global change impacts. The intra-African migration project facilitated networking among research institutions across Africa. This programme helps to support the objectives of the UNEP/CMS African-Eurasian Migratory Land-birds Action Plan (AEMLAP) and the Migrant Landbird Study Group (MLSG), and meets the growing need for better understanding of the drivers of avian migratory patterns on the continent.

Key co-supporters

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

Research team 2021

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Prof. Desire Dalton (NZG)
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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. However, some aspects of island ecology and evolution remain poorly understood. This programme studies patterns of adaptation and speciation on islands worldwide and conducts detailed studies using birds from the Gulf of Guinea, Cape Verde and Tristan islands as study systems.

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 ecological release. Low species richness also results in fewer predators and parasites. During the last decade, our team has systematically addressed multiple aspects of the island syndrome.

The 'island rule' posits that small species tend to become larger on islands and larger species tend to become smaller. Island birds also tend to have more muted plumage coloration than their mainland counterparts. However, the ecological drivers and molecular mechanisms of these evolutionary patterns are poorly known.

Bird song is directly linked to fitness through its role in mate attraction and territory defense and, hence, is under strong selection for efficient transmission. In species-rich communities, there is considerable competition for acoustic space, so mainland species tend to partition the acoustic space into narrow temporal and spatial (frequency bandwidth) windows to minimize interference. By contrast, the acoustic space of species-poor islands is predicted to be less saturated.

Reduced parasite levels on islands could lead to the evolution of weaker immune systems, as suggested by the extinction of many Hawaiian birds after the introduction of an avian malaria vector. This hypothesis was studied through a collaboration between Claire Doutrelant, Rita Covas, Martim Melo, Claire Loiseau and Benoit Nabholz, using a large-scale genomic approach to measure the diversity of hundreds of immune response genes. Results from Gulf of Guinea birds suggest that both genetic drift and relaxed selection lead to a decrease in the immune functions of island species. In addition, human-driven habitat change is likely to alter vector-parasite-host dynamics. Claire Loiseau, Martim Melo and a team of entomologists are studying how land-use practices influence avian parasites on São Tomé Island.

Finally, the Iago Sparrow *Passer iagoensis* is being used to study various adaptive processes among island birds. It occurs across a wide aridity gradient endemic at the Cape Verde archipelago, and thus constitutes an excellent model to understand how birds may adapt to an increasingly arid world. It also makes a good model to study the evolution of commensalism, as humans only colonised the archipelago 500 years ago, and some islands remain uninhabited. A collaboration led by Martim Melo, Ângela Ribeiro, Rauri Bowie, Mark Ravinet and José Cerca is combining fieldwork with genomics to untangle its recent micro-evolutionary history.

Activities in 2021

- Funding has been secured for two new post-doctoral researchers to study the island syndrome. Raquel Ponti will work with Rita Covas and Claire Doutrelant to study the ecological and molecular mechanisms of morphological evolution in island birds, and Ana Leitão will investigate experimentally whether the changes in bird colouration on islands are driven by the reduction in predation and parasite pressure or by reduced inter-specific competition.
- PhD student Alois Robert's research confirmed that birds on islands in the Gulf of Guinea experience less acoustic interference (both from birds and insects) than those on the mainland, resulting in reduced acoustic overlap with other individuals and species. This lower competition for acoustic space translates into the songs of island species occupying a broader frequency

bandwidth than the songs of their mainland counterparts – a pattern that is consistent with the character release hypothesis predicted from the lower levels of interspecific competition. However, no clear effect of the island environment could be detected on song complexity.

- Genomic analyses of diversity and selection of genes underlying avian immune responses were completed. Relaxed selection caused by reduced parasite pressure was identified for genes underlying the Major Histocompatibility Complex, which plays a central role in adaptive immune function.
- Surveys of birds on São Tomé found a higher prevalence of *Plasmodium* parasites in human-disturbed areas, whereas *Leucocytozoon* parasites tended to be associated with native habitats (as their vectors depend on streams with clear running water) and had a high level of endemism.
- In order to sample a broader range of avian parasites, we tested different sets of primers that will allow sequencing a great diversity of avian endoparasites in a single sequencing run.
- Bioinformatic analyses were conducted on SNP RAD-sequences from 339 Iago Sparrows as well as 23 full genomes. The results will identify genes linked to adaptation to arid environments.

A Newton's Sunbird *Anabathmis newtonii*, endemic to São Tomé Island, gives its song. Birds on islands have more variable songs because the acoustic space is less saturated with songs and calls from other vocal organisms, such as birds and insects. As a result, the frequency bandwidth of island species' songs are broader than those on the mainland (Photo: Lars Petersson).

- Genomic data from Tristan's *Nesospiza* finches collated by Bengt Hansson and Martin Stervander have provided novel insights into this recent adaptive radiation. A paper is being prepared on these results.

Highlights:

- PhD student Alois Robert published two papers on song evolution on islands in 2021 to complete this line of study: one in *Journal of Avian Biology* and one in *Journal of Evolutionary Biology*.
- The first genome-wide comparison of diversity comparing island birds with their mainland counterparts found evidence of both genetic drift and relaxed selection in decreasing the immune response ability of island species.
- Funding was secured for an expedition to sample Iago Sparrows across a human-presence gradient to study the evolution of commensalism.

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 help to understand and conserve island species.

Key co-supporters

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

Research team 2021

Dr Martim Melo (FIAO, UCT/CIBIO, U. Porto)
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Dr Rita Covas (FIAO, UCT/CIBIO, U. Porto)
Dr Claire Loiseau (CIBIO, U. Porto)
Dr Mark Ravinet (U. Nottingham)
Dr José Cerca (U. Oslo)
Dr Martin Stervander (Natural History Museum, London)
Dr Luis Valente (Naturalis Biodiversity Center, Leiden)
Prof. Rauri Bowie (U. California Berkeley)
Prof. Bengt Hansson (Lund U.)
Prof. Peter Ryan (FIAO, UCT)
Dr Raquel Ponti (CIBIO, U. Porto)
Dr Ana Leitão (CIBIO, U. Porto)

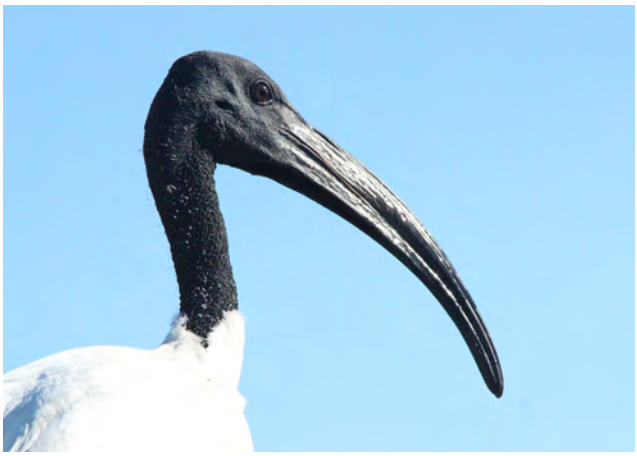
Smart beaks – non-visual senses in birds

Most birds have excellent vision, which is part of what makes birds such an appealing group to study. However, birds also use other senses to navigate their world. This project investigates the tactile senses in their beaks to understand the links between bill-tip anatomy and foraging ecology. The main focus is on three species of southern African ibises that forage in different habitats. All three have a honeycomb pattern of pitting in the bones of the bill tips, which suggests they should be able to forage using the sixth sense "remote touch", detecting small vibrations made by prey as they burrow or swim through the foraging substrate (soil, mud or water).

Carla du Toit started this project as an MSc student in 2017, upgrading to a PhD in 2018 which she completed and submitted at the end of 2021. Her research focuses on the anatomy of the bill-tip organ in probe-foraging birds, including modern ibises and extinct species in the paleontological record. The bill-tip organ of probe-foraging birds is made up of mechano-sensory receptors embedded in densely clustered pits in the bone of the bill tip. Although the general structure of the bill-tip organ is similar across all probe foraging species that possess it, there is variation in the shape and orientation of receptors among species. Carla uses three ibises as a model to investigate the link between the morphology of the bill-tip organ and the birds' foraging ecology: Hadeda Ibis *Bostrychia hagedash*, Sacred Ibis *Threskiornis aethiopicus* and Glossy Ibis *Plegadis falcinellus*.

Carla is also exploring whether these patterns can be extrapolated to infer information about the foraging ecology of fossil birds. If there is a strong link between the morphology of the bony parts of the bill-tip organ and foraging behaviour, we can use the structure of fossil beaks to infer information about the palaeoecology of extinct birds. In 2020, we published an extensive review of the bone structures of the beaks of over 500 species from all orders of extant birds. This established that we can determine the presence of a remote-touch-capable bill-tip organ in modern birds solely from the structures of their beak bones. Using this knowledge, we have been able to infer the foraging ecology of some of the most basal members of the avian family tree, shedding light on some contentious questions regarding the evolution of modern birds.

We have shown how some of the earliest known modern birds from the fossil record, the lithornithids (which evolved during the end of the Cretaceous Period), possessed remote-touch bill-tip organs. This shows that this remarkable sense evolved very early in the clade of modern birds. We have also shown how the organ is plesiomorphic in all modern paleognathous birds, including the extinct elephant birds and moas, and is vestigial in all except kiwi.

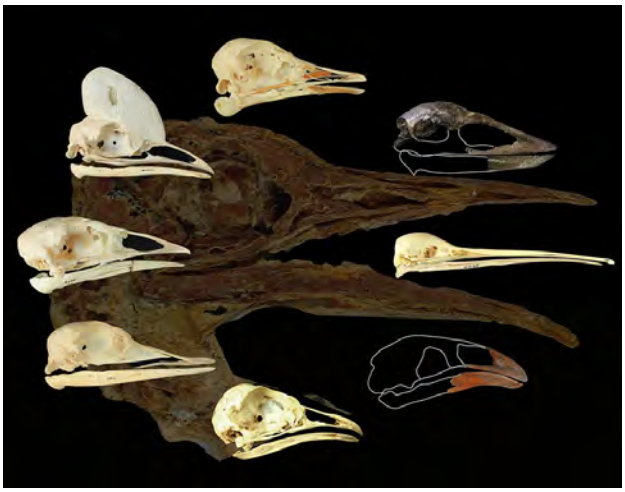


Sacred Ibis: wild ibises were studied to understand their foraging behaviour at Strandfontein, Velddrif, Kirstenbosch and Scarborough (Photo: Carla du Toit).

Activities in 2021

- On completion of her experimental work assessing the tactile foraging behaviour of Hadeda ibises at the end of 2020, Carla spent the year writing up the remaining chapters of her doctoral dissertation. She has submitted it for examination, and we await the results from the examiners.
- Carla completed her analyses of the behavioural data on Hadeda ibis foraging, and her results indicate that when using remote-touch to locate

prey, the birds are more successful at foraging in wet soils than dry ones. However, if the birds are unable to use remote-touch (and simply rely on direct contact with prey), the water content of the soil had no effect on foraging success. Thus, her study indicates that the higher foraging success rate of Hadeda Ibises in wetter soils is not due simply to "ease" of probing, but rather the birds find it easier to actually detect their prey using remote-touch when there is more water in the soil because vibration cues are better transmitted through saturated substrates. This pattern could have important implications when understanding the habitat requirements of remote-touch probe-foraging birds (such as ibises and shorebirds). Furthermore, this may in part explain why the recent range expansion of Hadeda Ibises is correlated with increased irrigation of soils.



Skulls and fossils of paleognathous birds (the group containing ostriches and emu), all of which we have found to have bill-tip organs, including the extinct elephant birds and moas, dating back at least to the Cretaceous Period in the extinct lithornithids. The organ is now vestigial in all except the kiwi from New Zealand (Photo: Carla du Toit).

Highlights:

- Carla completed and submitted her PhD thesis for examination in November 2021.
- Overall, her results indicated that there are clear ecomorphological links between the structure of the remote-touch bill-tip organ and interspecific differences in the foraging ecology of ibises (and consequently, likely other remote-touch probe-foraging birds). Her results have shown links between both bone morphology and soft tissue anatomy and the different species foraging behaviour and use of different substrates for foraging. She has also shown how tactile bill-tip organs can be identified looking at the bones of birds' beaks in the absence of soft tissue structures, which is of great use to palaeontologists studying the sensory ecology of extinct birds.
- Our article concerning the evolution of the remote-touch bill-tip organ in paleognathous birds (the clade of birds containing ostriches, emu and kiwi) continues to rank very highly, remaining in the top 5% of all research outputs scored by Altmetric (a measure of how much people and the media have discussed the article online), and has been favourably cited multiple times since it was published a year ago.

Impact of the project

This project helps us to better understand the links between anatomy, morphology and behaviour in birds. From a conservation and global change perspective, it allows a better understanding of the substrate conditions under which ibises are best equipped to forage, improving our understanding of potential mechanisms underlying the range expansion of Hadedas into the south and west of South Africa, and the likely impact of drought and ongoing climate drying on the foraging success of this and other ibis species.

The comparative work on palaeontological specimens has improved our understanding of the ecology of extinct birds, and shed light on the evolution of this unique sensory system. By changing our understanding of the morphology and behaviour of some of the earliest ancestors of large clades of modern birds, our findings have shed light on a major sensory ecological trend in the evolution of modern birds and dinosaurs.

Key co-supporters

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

Research team 2021

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

Student: Carla du Toit (PhD, UCT)

Impacts of power infrastructure

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

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

Activities in 2021

- PhD student Christie Craig, based at the Endangered Wildlife Trust, is studying 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. During 2021, Christie did the seventh and final quarterly powerline survey in the Karoo. Over the two years, 197 incidents were recorded. Blue Cranes were killed most often (93), followed by Ludwig's Bustards (19) and Pied Crows (16). Incidents tended to be concentrated in hotspots associated with close proximity to waterbodies; further analysis will clarify this relationship. Christie repeated the 155 km Swartland powerline survey in January 2021 (the first was done in December 2019). Similar to the 2019 survey, 60% of all incidents recorded were found on a 2 km stretch of transmission line near Darling – proximity to a pan is what is causing this hotspot.
- In June and August 2021, Christie and the EWT team fitted a further 10 Iridium satellite tracking devices to Blue Cranes in the Western Cape, adding to the 5 devices already fitted. The data from these and the 15 devices already deployed over the last five years will be used to help assess Blue Crane powerline collision risk.
- Christie conducted interviews with a further 16 farmers to understand how the agricultural landscape is changing and how this could affect cranes. This brings the total number of interviews conducted in the Overberg/ Swartland to 38.
- In September, Christie, the EWT team and Ezemvelo KZN Wildlife conducted an aerial survey of cranes in the Eastern and Northern Cape. In total, 9 159 Blue Cranes were counted, 54% of which were on cultivated/irrigated pasture lands (lucerne). Some of these were in very large flocks with one group of over 1 200 cranes. Flocks of this magnitude can cause damage to lucerne through trampling, potentially causing conflict between farmers and cranes.
- Over the last three years, Blue Crane breeding success in the Overberg and Swartland has averaged at 0.52 chicks per pair, only half the

Christie Craig and co-supervisor Lara Jordan fitting a satellite tracker to a Blue Crane in the Overberg (Photo: Bradley Gibbons).

fledgling rate in the grasslands and Karoo. The mechanisms leading to nest failure are not clear, and CB student Michelle Brouwer was recruited to investigate possible causes of low breeding success. Of the six monitored nests that failed, half were predated by Pied Crows *Corvus albus*.

- Robin Colyn's proposal to upgrade his MSc to a PhD was approved. His study infers the factors determining the distributions of range-restricted larks in the Karoo and montane grassland regions of 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. He has completed his fieldwork, but progress with drafting papers towards his thesis has been slow following his emigration to Canada.
- Sanjo Rose completed her second field season on Agulhas Long-billed Larks *Certhilauda brevirostris*, a little-known, range-restricted lark. Funding for the study was obtained from a wind farm development. Understanding the habitat use, breeding requirements and threats to nesting can help understand the likely impact of the wind energy infrastructure on this and other ground-nesting lark species in the Overberg.
- Estimates of bird flight heights are crucial to assess the risk of collision mortality with wind turbines and other infrastructure. Nicolas Prinsloo, a student of Nico de Bruyn (U. Pretoria), developed a photogrammetric approach to estimate flight height from an array of linked digital SLR cameras. A paper describing the technique was published in the *Journal of Zoology.*

Highlights:

- The results of Jess Shaw's long-term experiment to assess the efficacy of marking earth wires on transmission lines to reduce bird collision mortality in the eastern Nama Karoo was published in *Condor – Ecological Applications*. It shows that flappers and static flight diverters are both effective at reducing the collision rate of Blue Cranes, but have little efficacy for bustards.
- Alan Lee oversaw the publication of former CB student Matt Macray's project on the impacts of fences on tortoises in the southeastern Karoo in the *Journal of Nature Conservation*. The addition of an electrified bottom strand to prevent mammals from digging under jackal-proof fences results in significant mortality of tortoises.
- Sanjo Rose located 28 Agulhas Long-billed Lark nests. Most were in remnant patches of Renosterveld vegetation, often close to agricultural lands. Breeding success was low due to predation with at least eight different predators, including Boomslang, Honey Badger and Caracal.

A pair of Agulhas Long-billed Lark chicks (Photo: Sanjo Rose).

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.

Research team 2021

Prof. Peter Ryan (FIAO, UCT)
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Vonica Perold (FIAO, UCT)
Samantha Ralston-Paton (BLSA)
Dr Tim Reid (ANU, Canberra)
Dr Jess Shaw (Scottish Natural Heritage)
Tanya Smith (EWT)

Students:; Robin Colyn (PhD, UCT); Christie Craig (PhD, UCT); Sanjo Rose (MSc, UCT).

Conserving Martial Eagles

This project aims to understand the factors driving a decrease in the population of Martial Eagles *Polemaetus bellicosus* in South Africa, with a particular focus on the declines observed within the 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.

The 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 (2007-2012), 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 and the species was recently 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 outside protected areas. Contrary to this hypothesis, we have not found evidence for low survival during these early life stages, despite ranging widely beyond protected area boundaries. However, GPS tracking of adult birds and nest monitoring have detected 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.

Two factors contribute to the low breeding productivity: a low proportion of pairs attempting to breed and low breeding success. We continue

A nearly fully grown Martial Eagle chick. The photo was taken with a GoPro camera attached to our state-of-the-art telescopic pole that was funded by a generous private donation (Photo: Megan Murgatroyd).

Yellow B2 photographed during early August 2021 near Lower Sabie, Kruger National Park, 13 km from its natal site. This was the first resighting of the three-year-old Martial Eagle, which was ringed as a nestling in November 2018 (Photo: Jen Lawrence).

to study breeding performance in the KNP to enable a more comprehensive understanding of the environmental drivers of poor breeding performance, as well as to track eagles to determine the frequency and cause of mortalities.

Activities in 2021

- Of 25 occupied breeding territories monitored in KNP, 13 pairs attempted to breed, which is only the second time since the project started that more than half of the pairs did so. Overall breeding productivity was also the highest on record at 0.32 chicks per pair.
- Remote cameras were installed at six nests: three were successful; one's egg did not hatch (the python in the tree below the nest may have been responsible for its failure by keeping the adult eagles away), and the other two nests were not used.
- A donation allowed us to purchase a state-of-the-art telescopic camera-pole that extends 18 m (nearly 5 m more than our previous one) and means that we are now able to see into all our nests.

Highlights

- We received a re-sighting of an immature Martial Eagle, which was ringed as a nestling in 2018. We hope to ring more nestlings in the coming season.

Impact of the project

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

Key co-supporters

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

Research team 2021

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John Davies (EWT)
Dr Gareth Tate (EWT)

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 of 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. Surveys across northern Botswana have been completed, and Rochelle Mphetlhe has just completed a repeat of the transects in the south of the country for her MSc.

We also are a key partner in the conservation of the Bearded Vulture *Gypaetus barbatus* in southern Africa. We continue to collaborate with Sonja Krüger from Ezemvelo KZN Wildlife and others on the conservation of this important population. Our previous research found that territorial abandonment was higher in areas surrounded by more human settlements, which we attributed to the direct impacts of people on nesting pairs. CB MSc student Imthiaz Sheik Abbass explored an alternative explanation - that Bearded Vultures avoid these areas for foraging, and that increased human settlements cause a reduction in the areas of suitable habitat, leading to territorial abandonment. His research suggests that this could indeed be a potential additional explanation for the patterns we observed. The conservation focus for this species has now shifted to building a captive breeding programme with the hope of establishing an 'insurance' population away from the Maloti-Drakensberg Mountain population. This project builds on Christiaan Brink's published CB MSc project.

Activities in 2021

- We recently developed a wind farm collision risk model for Cape Vultures *Gyps coprotheres*. Almost all organisations that have tracked Cape Vultures have collaborated and shared their data to help build this model. This risk model will help ensure that developers can site wind turbines in locations that are seldom used by Cape Vultures and thereby minimise collision risk, and will become a mandatory screening tool for all windfarm sites in South Africa. The model was developed by Francisco Cervantes under the guidance of Arjun Amar and Meg Murgatroyd.
- To understand the prevalence and spatial distribution of poison-use for predator control, we produced a heatmap of poison-use for South Africa based on interviews with farmers. We also identified predictors of a landowner's propensity to engage in poison use. This study was published in *Ambio* in early 2021.
- 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.
- Andrea Santangeli, in collaboration with partners Vultures Namibia and colleagues at Imperial College London, has developed an Artificial Intelligence algorithm to identify camera trap images that include a vulture with a wing tag. This is useful as it greatly facilitates the processing of camera trap images used for resighting wing tagged vultures, building a recapture history of reach individual bird, and studying survival. The system will be released in 2022 along with the accompanying paper, to be published in *Ibis*.
- Rochelle Mphetlhe, working in collaboration with Raptors Botswana, completed her repeat of nearly 25 000 km of raptor road transects, first

surveyed in the 1990s. Rochelle will register and write up the results of these surveys for her MSc in 2022.

Highlights

- People's perception of vultures can often be influenced by information on social media. Arjun Amar and Andrea Santangeli were co-authors on a paper that highlighted the influence that fake news can have on farmers perception that vultures are killers of livestock. This paper was produced with the following cartoon.

Lambertucci, S. A. et al. (2021). **Presumed killers? Vultures, stakeholders, misperceptions and fake news**. Conservation Science and Practice

- Christiaan Brink submitted his PhD thesis in 2021, and it was passed with minor corrections. He is now managing BirdLife South Africa's Raptor and Large Terrestrial Bird Project.
- Christiaan was awarded the 2021 Best Early Career Research Prize for his MSc research on Bearded Vultures published in *Ostrich* in 2020.
- Andrea Santangeli and colleagues from Vultures Namibia and Spain published a study in *Biological Conservation* on the survival of Lappet-faced Vultures based on resightings of wing-tagged individuals.
- Arjun Amar collaborated with researchers in Spain and South Africa on a paper exploring the difference in how vultures in these two regions use protected vs agricultural land. This paper was published in *Biodiversity and Conservation*.
- BioTherm Energy helped support two vulture projects: one, in collaboration with VulPro, to track Cape Vultures from Potberg, the Western Cape's only vulture colony, and one to help co-fund our Cape Vulture collision risk model, being led by Franciso Cervantes. Several vulture nestlings were fitted with tracking devices at Potberg in 2021, and adults are due to be tagged in 2022.
- Sonja Kruger and Arjun Amar published a review in *'Imperiled: The Encyclopedia of Conservation*' which synthesised 20 years of research on the Bearded Vulture population of Southern Africa.

Impact of the project

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

Key co-supporters

DSI-NRF CoE grant; NRF Innovation Scholarship; ABAX Foundation; BioTherm Energy; 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.

Research team 2021

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Ms Kerri Wolter (VulPro)
Dr Glyn Maude (Raptors Botswana)
Dr Richard Reading (Raptors Botswana)
Dr Gareth Tate (Endangered Wildlife Trust)
Dr Andrew Tucker (CSVet, Pretoria)
Dr Beckie Garbett (BirdLife International)
Dr Francisco Cervante (FIAO, UCT)
Dr Chris Briggs (Hamilton College, USA)

Students: Christiaan Brink (PhD, UCT), Imthiaz Sheik Abbass (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 global change. We are also investigating how high temperatures influence breeding success.

The long-term project has provided nest boxes to 20 ground-hornbill groups in the Associated Private Nature Reserves, adjacent to Kruger Park. Together, these groups make 12-15 breeding attempts each year. 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, is studying the hornbill's social structure and individual contributions to breeding and territory defence. Kyle is comparing different groups' dawn choruses and using play-back experiments to determine if the birds recognise different groups. He also is using camera traps at the nests to obtain insights into the hornbills' private lives, and is analysing long-term data to investigate the environmental and social factors affecting breeding performance.

MSc student Carrie Hickman, supervised by Rita and Susan Cunningham, is investigating whether high air and nest temperatures impact hornbill nestlings by measuring nestling growth, fledging size and telomere length (a measure of physiological condition). iButtons have been installed inside nests to obtain hourly temperature recordings. The results from these analyses will assist in designing better nest boxes for the species.

Kyle-Mark Middleton and Carrie Hickman measuring a 75 day-old Southern Ground-Hornbill chick (Photo: Susie Cunningham).

Activities in 2021

- Kyle's analyses show that different groups have unique vocal 'signatures', with males producing lower frequency calls than females. Deep learning algorithms correctly classify 90% of female territorial calls to an individual bird.
- He also found a generally positive effect of rainfall, and negative effect of high temperatures of breeding success, and varied effects of breeding group composition.
- Non-invasive genetic sample collection from known individuals is continuing through shed feathers to determine relatedness between individuals and how this influences investment in cooperative behaviour.
- Camera traps were placed at 13 nests before the 2020/21 breeding season to record birds provisioning food, and iButtons were installed inside each nest. These showed that adults provisioned the most, followed by sub-adults, whereas juveniles seldom contributed.
- Blood sampling of nestlings continued to investigate the effects of temperature on physiology, measured as the rate of telomere attrition. This also allows chicks to be sexed.

- Carrie began focal observations to investigate behavioural repsonses to high temperatures, and used online photographs to supplement her observations. She found that the birds start to display heat-dissipation behaviours at lower temperatures in winter.
- Carrie and Kyle attended the Southern Ground-Hornbill reintroduction workshop hosted by BirdLife South Africa and MBHP.
- The project created a new website, providing general information on the research and conservation conducted within the area. Presentations and popular articles also created awareness about the project.
- iButton data was used to improve the design of artificial nests.
- Ongoing repairs to and replacement of artificial nest boxes ensured that ground-hornbills can continue to thrive in the study area, which has few natural nest cavities.

Highlights:

- Carrie and Kyle attended the Hot Birds Research conference in Skukuza.
- Carrie was awarded a grant for her research from the Rufford Foundation.
- All the fledglings from nests in the 2019/20 breeding season survived and remain with their natal groups.
- The 2020/21 breeding season saw seven chicks fledge from 13 nests. Methods are being developed to sex birds whilst still in the egg.
- Three newly designed nests were installed, equipped with iButtons to determine if they provide suitable thermal conditions for breeding.
- New nests were placed outside the study site to encourage natural dispersal.
- Footage was obtained of ground hornbill groups attacking incubating females in neighbouring territories. Our camera traps have filmed five nest take overs, where groups have moved in and bred in a neighbouring group's nest.
- A method was developed to identify individual birds based on their facial features.

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.

Installing a new artificial nest (Photo: Carrie Hickman).

Key co-supporters

DSI-NRF CoE grant; 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 in Africa; Wild Wonderful World; Blue Skye Society Trust.

Research team 2021

Dr Rita Covas (FIAO, UCT and CIBIO, U. Porto)
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Dr Fanny Rybak (U. Paris-Sud, France)
Dr Susie Cunningham (FIAO, UCT)

Students: Kyle-Mark Middleton (PhD, UCT); Carrie Hickman (MSc, UCT).

Data and field assistant: Thandiwe Knutson

Conserving Benguela endemic seabirds

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

The lack of spatial management of the fishery for small pelagic fish has resulted in local over-exploitation of sardines and anchovy. Throughout the last decade, the small pelagics fishery has failed to meet its quota almost every year, indicating a paucity of these fish. African Penguins *Spheniscus demersus*, Cape Cormorants *Phalacrocorax capensis* and Cape Gannets *Morus capensis* all depend largely on these same fish, and all three species are now listed as Endangered. Understanding the drivers behind such population changes is essential to mitigate these declines. This is a large, multi-faceted programme with key participants including Pierre Pistorius, Lorien Pichegru and Maëlle Connan (NMU), David Grémillet (CNRS Montpellier), former post-docs Tim Cook (Paris) and Richard Sherley (Bristol), collaborators at BLSA (Alistair McInnes, Christina Hagen) and DEA (Azwianewi Makhado and Rob Crawford), as well as several post-doctoral students.

Activities in 2021

- The experimental closure of commercial fishing for small pelagic fish around key penguin breeding islands stopped in 2021. Negotiations for longer-term closures around key breeding colonies took place in 2021 and a Task Team assigned by the Minister of Forestry, Fishery and the Environment came up with proposed closures based on GPS data from foraging penguins and fishing catches around the six main breeding colonies. However, additional negotiations between environmentalists and fishing companies ensued and the locations of fishing exclusion areas have yet to be confirmed.
- The long-term monitoring of African Penguins continued in Algoa Bay, with tracking data collected on Bird Island in May 2021. No tracking data could be obtained from St Croix due to the low numbers of penguins breeding there.

Dr Alistair McInnes from BirdLife South Africa observes African Penguins on Dyer Island (Photo: Pierre Pistorius).

Cape Cormorants are unusual among cormorants in being able to roost at sea. However, observations during COVID-19 lockdowns suggest that human disturbance contributes to this behaviour close to shore (Photo: Peter Ryan).

- A weighbridge was re-installed on St Croix in March 2021 by Alistair McInnes and is now functional. Alistair is exploring the use of weighbridges and transponder readers to monitor penguin fish catches in relation to foraging effort with minimal disturbance to the birds.
- Hydrophones to measure ship noise were deployed on breeding penguins from Bird Island. Lorien Pichegru received a grant from the NRF to further develop this work and deploy several static hydrophones in Algoa Bay. This builds on the collaboration between NMU, BirdLife South Africa and the CNRS in France to investigate the factors driving the decline in penguin numbers in Algoa Bay since 2016.
- Lorien and Shaun Welman (NMU) used automated cameras to assess the thermoregulatory behaviour of penguins in natural and artificial nests that were equipped with temperature and humidity recorders. They found that the latest artificial nests with a double ceramic layer buffer environmental conditions inside the nest even better than natural guano burrows. They also found that African Penguins breeding in surface nests exposed to the sun started panting at air temperatures as low as 22°C, compared to 25°C in shaded nests.
- NMU MSc student Praxedes Rukuni, supervised by Lorien, Giannina Passuni and Shaun Deyzel (SAEON), completed her thesis on food web stability in Algoa Bay using meso-zooplankton functional diversity metrics. She found that the anchovies targeted by penguins breeding on Bird Island fed mostly on large crustaceans, whereas those targeted by penguins from St Croix Island fed on a wider range of smaller, less energetically beneficial prey, reflecting the less productive waters close to St Croix.
- NMU MSc student Catherine Currin, supervised by Lorien and Andre Ganswindt, completed her thesis that used a newly-designed electronic heart rate recorder to compare stress levels in captive penguins. Although she could only use a small proportion of the data recorded by the eggs, she showed that encounters with conspecifics including interactions with a mate elicited much higher heart-rate responses than the presence of humans in their enclosures. These results confirm that African Penguins can get habituated to the presence of humans.
- Former NMU post-doc, Giannina Passuni, mentored by Lorien Pichegru, published her

A Cape Fur Seal killing a Cape Gannet on Malgas Island during October 2021 (Photo: Peter Ryan).

paper on the contribution of penguin guano from St Croix Island on water quality and productivity around the colony. She estimated that 45.4 tons of nitrogen (N) and 8.4 tons of phosphorus (P) were produced annually by the birds although only 5-20% of the N washed into the ocean.

- NMU Research Associate and BLSA employee Tegan Carpenter-Kling submitted a large collaborative paper to *PLoS One* reporting pre- and post-moult distribution of African Penguins from various colonies around South Africa.
- Katharina Reusch completed her PhD on the foraging ecology of Kelp Gulls *Larus dominicanus* and is currently writing up two further publications from the thesis.
- Nosipho Gumede continued her MSc, supervised by Newi Makhado, Mduduzi Seakamela and Peter Ryan, on long-term variation in the diet of Cape Fur Seals *Arctocephalus pusillus*, and the potential for competition with fisheries and seabirds.
- David Grémillet and Lorien Pichegru continued their long-term study tracking the foraging ranges of Cape Gannets breeding on Malgas Island, which was initiated in 2002. However, high levels of predation by Cape Fur Seals in the colony prevented significant data collection in 2021. The issue has been debated with SANParks and SANCCOB has offered to put a dedicated ranger on the island early in the breeding season to prevent further incursions by seals. The management of the Kelp Gull population by SANParks on this colony continued in 2021, to limit predation of gannet eggs.
- As part of their collaboration, David and Lorien submitted a paper with Nicoals Courbin on the 'Seascape of fear' hypothesis for Cape Gannets. In it, they suggest that gannets' foraging strategies may be shaped by both avoidance of competition with fishing vessels as well as avoidance of Cape Fur Seals.
- Pierre Pistorius continued annual tracking of Cape Gannets from Bird Island, Algoa Bay, and Andrea Thiebault used tracking data, miniaturised video cameras and microphones to confirm that acoustic data alone can be used to study at-sea behavioural patterns (time-activity-budgets) in gannets. Andrea's findings were published in *Animal Biotelemetry*.
- Pierre contributed long-term data on Cape

Repeated incursions by Cape Fur Seals into the Cape Gannet colony on Malgas Island at the start of the 2021 breeding season caused many birds to abandon their breeding attempts (Photo: Peter Ryan).

Gannet diet composition for a paper assessing a new method for measuring long-term changes in biodiversity which was published in *Philosophical Transactions of the Royal Society B*.

- Zanri Strydom continued her PhD at NMU on the foraging behaviour of Cape Gannets in relation to their age and experience, co-supervised by Herve Fritz and Jan Venter from the George campus of NMU, and David Grémillet and Lorien Pichegru. Zanri managed to deploy GPS and accelerometers on 20 gannets at Malgas Island in November 2021, but none was of known age due to the small size of the colony. She will also sample Cape Gannets at Lambert's Bay in January 2022.

Highlights:

- Katharina Reusch received very favourable reviews from the examiners of her PhD on the foraging ecology of Kelp Gulls.
- Lorien Pichegru has been asked to step in as Acting Director of the Coastal and Marine Research Institute at NMU until a dedicated full time position is created by the university.
- Seven papers were published in peer-reviewed journals during 2021.

Key co-supporters

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

Research team 2021

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Dr Jon Green (U. Liverpool)
Dr David Grémillet (FIAO, UCT and CNRS)
Dr Azwianewi Makhado (Oceans & Coasts, DEA)
Dr Alistair McInnes (BLSA)
Dr Florian Orgeret (NMU Post-doc)
Dr Richard Sherley (U. Bristol)
Dr Andrea Theibault (NMU Post-doc)
Dr Ralph Vanstreels (NMU Post-doc)

Students: Katharina Reusch (PhD, NMU), Zanri Strydom (PhD, NMU), Catherine Currin (MSc, NMU), Nosipho Gumede (MSc, UCT), Praxedes Rukuni (MSc, NMU), Victoria Stockdale (MSc, NMU).

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 field work takes place through the South African National Antarctic Programme (SANAP) at the Prince Edward Islands, Tristan da Cunha, Gough Islands and Antarctica. Fitz Institute 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 scheduled for the winter of 2024. During 2021, monitoring at Marion and Antarctica was undertaken by collaborating with CoE partners Azwianewi Makhado (DFFE) and Pierre Pistorius (NMU). Monitoring at Gough Island has been taken over by the RSPB. This project overlaps with the 'Island Conservation' and 'Moult and migration' projects.

Activities in 2021

- Stefan Schoombie completed his PhD on fine-scale foraging behaviour of albatrosses and petrels. In addition to analysing vast amounts of daily diary data for his PhD, Stefan also drafted a paper on the breeding biology of Sooty Albatrosses *Phoebetria fusca* and another on the re-establishment of Common Diving Petrels *Pelecanoides urinatrix* on Marion Island.
- Farisayi Dakwa completed his MSc on the population ecology of sympatric *Eudyptes* penguins at the Prince Edward Islands. His paper on long-term variation in their diet was published in 2021.
- Shamiso Banda completed her MSc on the foraging behaviour of Sooty Albatrosses at Marion Island in relation to environmental variability and fishing activities.
- Danielle Keys continued her PhD on the interaction between foraging behaviour and demographic responses in Wandering Albatrosses *Diomedea exulans*.
- Florian Orgeret, a post-doc at NMU, published a paper in *Journal of Animal Ecology* highlighting sex-specific differences in the at-sea distributions of Wandering Albatrosses using tracking data from both Marion Island and from the neighbouring French islands.
- Peter Ryan spent three months on Gough Island preparing for the mouse eradication attempt in winter 2021. While there, he took the opportunity to work with James Glass, head of Tristan's Fishery Department, to report on the impact of light pollution on seabirds from fishing vessels operating around the Tristan islands. He also collected data on plumage maturation in Tristan Albatrosses.
- Peter also was fortunate to spend four weeks in the Russian Arctic in August-September 2021, where he recorded the distribution and abundance of seabirds at sea. His most interesting finding was a concentration of post-breeding Little Auks *Alle alle* in relatively warm Atlantic Ocean water over the St Anna Trough. Little Auks tend to concentrate in colder, Arctic waters, and are widely regarded as a sentinel species for the impacts of climate change in the Arctic.
- Former student Chris Jones published a paper in *Animal Conservation* on the demographic impact of mouse predation on MacGillivray's Prion *Pachyptila macgillivrayi* chicks on Gough Island.
- Seabird tracking data collected over the last decade contributed to several papers attempting to identify key areas at sea for seabird conservation. Tammy Davies' multi-species

Pre-breeding Tristan Albatrosses check out potential mates on Gough Island. By visiting Gough in autumn, Peter Ryan was able to obtain photographs of hundreds of birds of known age and sex to compare their plumage maturation and moult with that of Wandering Albatrosses (Photo: Peter Ryan).

analysis published in *Conservation Letters* reported a foraging hotspot in the northeast Atlantic Ocean which is set to be identified as a protected area by the European Union. Other papers appeared in *Science Advances*, *Progress in Oceanography* and *Diversity and Distributions*.

- Theresa Burg's MSc student, Dilini Abeyrama, published a paper on the population genetics of yellow-nosed albatrosses in *Conservation Genetics*. She also started work on the population structure of Sooty and Light-mantled Albatrosses.
- Pierre Pistorius co-authored on a paper published in *Animal Conservation* assessing fine-scale interactions between boats and large albatrosses in the Southern Indian Ocean to assess bycatch risk. He also co-authored on a paper published in *Diversity and Distributions* on the taxonomy of rockhopper penguins.
- Lyle de Menezes continued his MSc on the trophic ecology of, and plastics loads in, petrels breeding at Marion Island. He is planning to hand in his MSc thesis in mid-2022.
- Azwianewi Makhado was elected vice-chair of the CCAMLR Scientific Committee for 2021 and 2022. He co-authored two CCAMLR reports on the competition between the krill fishery and pygoscelid penguins around the Antarctic Peninsula. This research will help develop better monitoring indices for adaptive management of the Antarctic krill fishery
- Kim Stevens extended her leave of absence from her PhD on the demography and at-sea movements of Grey-headed Albatrosses *Thalassarche chrysostoma* to continue to lead the RSPB team on Gough Island for a second year. She will only return to South Africa in October 2022.

Highlights:

- 19 papers on Southern Ocean seabirds and their conservation were published in 2021.
- Newi Makhado's tracking of Emperor Penguins *Aptenodytes forsteri* is contributing towards the establishment of one of the largest CCAMLR MPAs in the Weddell Sea.
- Stefan Schoombie completed his PhD and has taken up a post-doctoral position with Dr Chris Oosthuizen at SEEC.
- Shamiso Banda completed her MSc and was awarded the best student presentation at the Birdlife LAB conference.

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 2021

Prof. Peter Ryan (FIAO, UCT)
Dr Maelle Connan (NMU)
Dr Azwianewi Makhado (Oceans & Coasts, DFFE)
Prof. Pierre Pistorius (NMU)
Prof. Res Altwegg (SEEC, UCT)
Dr Theresa Burg (U. Lethbridge, Canada)
Dr Sarah Converse (Oregon)
Dr Jacob González-Solis (U. Barcelona)
Dr Steffen Oppel (RSPB)
Dr Richard Phillips (British Antarctic Survey)
Dr Henri Wiemerskirch (CNRS, Chize)
Prof. Rory Wilson (Swansea U.)

Students: Danielle Keys (PhD, NMU); Stefan Schoombie (PhD, UCT); Kim Stevens (PhD, UCT); Shamiso Banda (MSc, NMU); Farisayi Dakwa (MSc, UCT); Lyle de Menezes (MSc, NMU).

Field assistants: Danielle Keys (Marion 2020/21), Eleanor Weideman (Marion 2021/22)

Conserving islands and their birds

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

This programme is mainly concerned with the impacts of introduced predators, especially House Mice *Mus musculus*, but also is involved in the eradication or control of introduced plants and invertebrates. The impacts of House Mice on seabirds were only discovered in the early 2000s, following research by Fitz students in collaboration with the Royal Society for the Protection of Birds (RSPB) at Gough Island. Since then, mice have been found to attack seabirds on Marion Island, and plans are underway to eradicate the species at both islands. Despite the COVID-19 pandemic, the Gough Island Restoration Programme to eradicate mice from the island went ahead in 2021. Considerable progress also was made with planning for the proposed mouse eradication on Marion Island, and a biocontrol programme was initiated against an invasive scale insect at Tristan da Cunha.

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Activities in 2021

- Peter Ryan travelled to Gough Island in March 2021 to assist with the capture of insurance populations of Gough Buntings *Rowettia goughensis* and Gough Moorhens *Gallinula comeri* ahead of the eradication attempt in mid-winter 2021. We are still attempting to determine the cause of the failure of the eradication attempt; one hypothesis at this stage is that invasive slugs reduced the density of bait in some areas, allowing a few mice to avoid exposure to the bait.
- Peter also was involved in progressing plans to eradicate House Mice from Marion Island. Peter serves on the Mouse-Free Marion Management Committee and chairs its Scientific and Technical Advisory Group.
- The 2020 paper on the ongoing spread and rapid increase in impact of the introduced Soft Brown Scale *Coccus hesperidium* and its associated Sooty Mould *Seiridium phylicae* on *Phylica arborea* trees at Inaccessible Island, and its arrival on Nightingale Island prompted the RSPB to launch a biocontrol programme to limit the populations of Soft Brown Scale. Parasitic wasps were released on Nightingale Island in April 2021 and initial reports suggest that they have become established, with significant mortality of scale insects. It is planned for more wasps to be released on Inaccessible Island in 2022.
- Four papers were published in 2021: three led by post-doc Ben Dilley and one by former MSc student Chris Jones. Ben published two papers on Wilkins' Finches *Nesospiza wilkinsi*, a naturally extremely rare finch confined to Nightingale Island in the Tristan da Cunha archipelago, reporting its breeding biology and population size. His third paper was on the distribution and relative abundance of the Inaccessible Island Rail *Atlantisia rogersi*. Chris led on a paper on the demographic impacts of House Mice predation on MacGillivray's Prions *Pachyptila macgillivrayi* on Gough Island.
- Peter Ryan and Steffen Oppel (RSPB) had a paper accepted on the winter colony attendance of Southern Giant Petrels *Macronectes giganteus* at Gough Island. It reports how almost all breeding adults are present at their breeding colony from May, even though they only lay eggs in September, which has implications for their exposure to accidental poisoning during mid-winter rodent eradication attempts.
- Martim Melo conducted a field trip to islands in the Gulf of Guinea with two illustrators, Marco Correia and Cláudia Baeta, as a first step in producing a field guide to the birds of these extremely important islands, which relative to their size support the largest number of endemic bird species.

A helicopter spreads bait from a suspended bait bucket over the steep eastern slopes of Gough Island in early August 2021. Sadly a few mice avoided the poison bait, and it seems that the eradication attempt has failed, but the virtual absence of mice has provided a much needed respite for seabirds breeding on the island (Photo: Michelle Risi).

- Martim and former MSc student Bárbara Freitas (now at the National Museum of Natural History in Madrid) trained technicians from the Natural Park and the Príncipe Foundation to monitor the recently discovered Príncipe Scops-Owl using automated recording stations.

Highlights:

- Considerable progress was made with plans to eradicate mice from Marion Island. A non-profit company was set up to manage the operation as a partnership between the South African government and BirdLife South Africa. Anton Wolfaardt was appointed as Project Manager and Keith Springer as Operations Manager. Keith has an exceptional pedigree, having led successful eradications on Macquarie and South Georgia. He also wrote the draft operational plan for the Marion eradication, so hit the ground running in his position. Other key people appointed in 2021 include US-based fund-raiser Heidi Whitman, communications officer Robyn Adams and former Fitz stalwart, John Cooper, as news correspondent.
- Although the outcome was not what we wanted, the Gough Island Restoration Programme to eradicate mice from Gough went ahead in 2021 without any significant logistical hitches. This is encouraging for the Mouse-Free Marion project, which learned many valuable lessons from the Gough Project.
- Initial results were positive following the release of a parasitic wasp in a biocontrol programme against Soft Brown Scale at Nightingale Island in the Tristan archipelago in April 2021.
- Four papers were published in the peer-reviewed literature, and another paper is in press.
- Martim Melo co-authored a revised checklist to the birds of the Gulf of Guinea Islands.

Key co-supporters

Agreement on the Conservation of Albatrosses and Petrels; BirdLife International; DSI-NRF CoE grant; EU-BEST; Royal Society for the Protection of Birds; South African National Antarctic Programme; UK Overseas Territories Environment Programme; BirdLife SA; African Bird Club; TROPIBIO and BIOPOLIS programs of CIBIO.

Research team 2021

Prof. Peter Ryan (FIAO, UCT)
Dr Alex Bond (formerly at the RSPB)
Dr Richard Cuthbert (formerly at the RSPB)
Dr Ben Dilley (FIAO, UCT)
Dr Martim Melo (FIAO, UCT / CIBIO, U. Porto)
Dr Stefan Oppel (RSPB)
Dr Susan Miller (FIAO, UCT)
Andy Schofield (RSPB)
Dr Anton Wolfaardt (Mouse-Free Marion)

Research assistants: Kim Stevens, Vonica Perold and Roelf Daling (Gough 2020/22 and 2021/22).

Hot Birds – Climate change and desert birds

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

Released in mid-2021, the first part of the UN Intergovernmental Panel on Climate Change's 6th Assessment Report provides up-to-date and sobering insights into the accelerating pace of climate change. Extreme heat waves that were 1-in-10 year and 1-in-50 year events in the 19th Century now occur between three and five times more frequently. The release of the IPCC report occurred shortly after unprecedented heat waves in North America saw air temperatures approaching 50°C as far north as Canada's British Columbia, conditions unimaginable until recently.

Extreme climate events were a feature of the start of the HBRP's year too, with atypically high rainfall over much of South Africa's arid zone in the beginning of the year. PhD student Nicholas Pattinson and his colleagues found themselves stranded at our Southern Yellow-billed Hornbill research site in the Kalahari when the usually-dry Kuruman River bed was transformed into a raging torrent, leaving the researchers unable to leave the site for three weeks. The water reached levels unseen in recent decades and Nicholas and his field assistant found themselves having to swim out to nest boxes used by the hornbills and raise the boxes higher up the tree trunk to safety.

Despite the continuing COVID-19 pandemic, 2021 proved a successful and productive year for the HBRP. Most of the team were able to attend our biennial workshop held in August at the Skukuza Science Leadership Initiative campus in Kruger National Park. The workshop proved a productive and useful exercise, providing opportunities to take stock of current HBRP research and discuss emerging questions that will drive our future research. The year also saw a substantial increase in the HBRP's physiological research capacity, with our mobile physiology laboratory's maiden voyage to Namaqualand for two months at the start of the year.

HBRP research continued to generate high-impact publications. A 2021 review of how warming temperatures impact opportunity costs by Susie Cunningham and colleagues in *Frontiers in Ecology and the Environment* has already been cited 16 times, and a *Journal of Experimental Biology* review of thermoregulation in desert birds by Andrew McKechnie and colleagues 15 times. Other noteworthy papers published by the HBRP team during the year included Amanda Bourne's study of dehydration risk in incubating Southern Pied Babblers in *Conservation Physiology*, Lesedi Moagi's paper in *Journal of Experimental Biology* on stress associated with very hot days in the same species, and a paper by Andrew McKechnie, Susie Cunningham and colleagues at Ezemvelo KZN Wildlife documenting South Africa's first recorded heat-related mass mortality event among wild birds in late 2020.

Climate change impacts on behaviour and breeding success

Nicholas Pattinson completed his fieldwork for his PhD on the impacts of temperature versus resource availability on Southern Yellow-billed Hornbills, and is now writing up his results. Conditions at Nick's study site varied enormously during his PhD, from drought to extreme rainfall. Preliminary analyses suggest these large differences in background conditions affect physiological and behavioural patterns of thermoregulation.

Ben Murphy also completed his fieldwork for his PhD on how Fork-tailed Drongos mitigate effects of high temperatures on reproductive outcomes. Ben's 2020/21 field season was delayed due to the pandemic, and he finalised data collection during a short trip in October 2021. Ben also aided filming of the drongos for international nature documentaries.

Two new MSc students joined the "behaviour" branch of the HBRP team in 2021. MSc student Jaimie Whyte began her first field season on the impacts of temperature on behavioural thermoregulation, microsite use, and breeding behaviour in White-browed Sparrow-Weavers at Murray Guest Farm. Jaimie's work follows a long tradition of HBRP physiology research on this

species and will add pieces of the puzzle associated with behavioural changes and sub-lethal fitness impacts linked to high temperatures. Nazley Liddle joined Andrew McKechnie, Susie Cunningham, Marc Freeman and Callan Cohen on a reconnaissance trip to northern Kwa-Zulu Natal to locate a field site for her physiology and breeding behaviour work with Blue Waxbills. Nazley will register for an MSc in 2022 to examine interactions between temperature and humidity on thermoregulation and breeding success in this species, following their significant representation in the mass mortality event in the Pongola region in late 2020.

Red-list species and practical conservation 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 or those living in already-extreme environments. In 2021, the HBRP ramped up efforts to engage in research on red-listed species and testing of applied conservation mitigation measures.

MSc student Carrie Hickman continued data collection on the impacts of temperature on behaviour and breeding outcomes in Southern Ground Hornbills. Preliminary data from Carrie's work shows high temperatures cause birds to display heat dissipation behaviour year-round (even in winter), potentially impacting their ability to gain breeding condition following hot winters. She also showed that winters are warming faster than summers in the lowveld, highlighting an unexpected avenue of vulnerability for birds in this region. Carrie intends to upgrade to a PhD in 2022.

2022 CB MSc student Michelle Bouwer began preliminary data collection in Oct-Dec 2021 for her project assessing whether climate or land use change is driving changes in breeding productivity in Blue Cranes in the Overberg. Michelle will continue data collection in 2022.

CB MSc student Sean Morar headed to the Tankwa Karoo National Park at the very end of 2021 to begin a study assessing whether providing artificial shade at water points can keep water accessible to the small birds of South Africa's most extreme desert on days when ground temperatures can exceed 60°C. Sean's project is funded by WWF USA. If successful, SANParks will consider using shaders at water points in all the arid zone parks in order to mitigate dehydration-thermoregulation trade-offs faced by small birds during heatwaves.

Lara Strydom deploys a temperature sensor in a tree in the Kruger National Park. Her MSc research seeks to link biophysical models with LiDAR imagery of vegetation structure to evaluate the potential of cool, shady microsites to buffer birds against very high temperatures during severe heat waves (Photo: Andrew McKechnie).

Non-invasive techniques

The HBRP's use of non-invasive measurements of glucocorticoid ("stress hormone") concentrations to answer questions around the role of physiological stress pathways in modulating responses to very hot weather picked up pace in 2021. Dr Celiwe Ngcamphalala graduated with her PhD in September and published one of her chapters in *Physiological and Biochemical Zoology*. Late in the year, we received the gratifying news that Lesedi Moagi's paper on variation in stress levels in free-ranging Southern Pied Babblers had been short-listed for the *Journal of Experimental Biology*'s annual award for best paper in the journal. Michelle Bouwer's validation of this technique for Southern Yellow-billed Hornbills

was also published during the year and paved the way for Nicholas Pattinson to apply this approach to the hornbills in the southern Kalahari. Physiological differences among species mean that the analysis protocol for quantifying glucocorticoid-related molecules in bird droppings has to be validated for each study species, and the list expanded yet further during 2021 when BSc Hons student Kagiso Nhlapo established the best analysis technique for Red-winged Starling droppings. His findings mean this research tool can now be integrated into work on the habituated starling study population on UCT's campus.

Thermal physiology

Led by PhD student Marc Freeman in 2021, this component of the programme seeks to understand physiological processes that constrain avian performance in hot environments. The year saw data collection at a number of sites across the country using our new mobile lab. Based on an extensive data set of ~60 species at sites representing a continuum from arid to mesic, Marc completed a comparative analysis that revealed novel and surprising patterns in how birds cope with heat exposure. Unexpectedly, the data revealed that desert birds possess a more modest capacity to increase body temperature above normal levels than birds from cooler, more mesic habitats, but have also evolved more efficient evaporative cooling processes. A manuscript based on this analysis is currently under review at *Proceedings of the National Academy of Sciences*. A second major aspect of Marc's PhD investigates how high humidity affects birds' abilities to dissipate heat via evaporation; during 2021, he collected data for around 10 species in Namaqualand and a further 10 in the eastern Free State grasslands. The start of 2022 saw Marc depart for a site near the coast in northern KwaZulu-Natal where prevailing humidity levels are much higher than further west. Once he has collected data for species at this site, he will be able to test whether birds occupying more humid areas have evolved a better capacity for heat dissipation under humid conditions.

Otto Makola continued his MSc on heterothermy in southern African sunbirds and collected all his data during the course of 2021. This project sheds new light on the capacity of these nectivorous passerines to respond to periods of reduced energy supply or elevated energy demands using torpor, a short-term state of reduced body temperature associated with energy conservation. Otto's project is providing novel insights into physiological convergence between the Old World's sunbirds and the hummingbirds of the New World.

Susie Cunningham, Marc Freeman and Jaimie Whyte checking White-browed Sparrow-weaver nests in Askham for Jaimie's MSc project on how temperature affects breeding in this species (Photo: Andrew McKechnie).

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. PhD student Shannon Conradie who submitted her thesis in late 2021, has spent the last three years integrating cutting-edge biophysical modelling approaches and sophisticated techniques for predicting animal behaviour into new approaches to understand how birds cope under current rapid global heating and under the climates birds will experience later this century. Using data collected during previous HBRP studies of Kalahari species including Southern Yellow-billed Hornbills and Southern Pied Babblers, Shannon showed that the models she developed accurately predict the thermal physiology and behaviour of these species. In 2022, she will be heading over to North America for a postdoctoral fellowship funded by Iowa State University.

The year also saw the establishment of a collaboration between the HBRP and SANParks. Motivated by the increasing number of very hot days Kruger National Park is experiencing and the heat-related mortality event that struck northern KZN in late 2020, the project seeks to link drone-collected LiDAR data on vegetation structure and biophysical modelling to assess the availability of shaded refugia across landscapes in KNP and understand how these are affected by management practices. Lara Strydom, registered for a Masters in Environmental Management at the University of Pretoria, is currently collecting data for this project.

Highlights:

- The HBRP published 20 papers in international peer-reviewed journals in 2021.
- Susie Cunningham was invited to join UCT's prestigious Future Leaders Programme.
- Andrew McKechnie accepted an invitation to serve as subject editor for *Global Change Biology*, one of the highest-ranked journals focusing on climate change research.
- Celiwe Ngcamphalala graduated with her PhD from the University of Pretoria and accepted an appointment at the University of Cape Town. Her PhD research focused on the use of non-invasive measurements of stress hormones and addressed questions related to climate change and animal welfare, and she intends pursuing similar research in her new position.
- Jessica Roberts graduated with a Distinction for her MSc on the behavioural ecology of Dune Larks, a species endemic to the Namib Sand Sea.
- The HBRP team held a very successful biennial workshop in Skukuza.
- The HBRP mobile physiology lab – a converted offroad caravan with state-of-the-art thermal physiology equipment – undertook its maiden voyage to Namaqualand in early 2021. It was subsequently deployed to several field sites, and in the last few months of 2021 was used for a study of Pied Crows investigating whether lead poisoning affects thermoregulatory capacity, in collaboration with Vulpro.

Key co-supporters

DSI-NRF CoE grant; SARChi Chair in Conservation Physiology; UCT URC; U. Pretoria; NRF Thuthuka Grant; Tygerberg Bird Club; WWF USA; Rufford Foundation.

Research team 2021

Prof. Andrew McKechnie (U. Pretoria / SANBI)
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Dr Alex Gerson (U. Massachusetts)
Dr Alan Lee (FIAO, UCT / SANBI)
Dr Rowan Martin (FIAO, UCT)
Dr Ben Smit (Rhodes)
Dr Zenon Czenze (U. New England)
Dr Blair Wolf (U. New Mexico)
A/Prof. Amanda Ridley (U. Western Australia)
Dr Tom Flower (FIAO, UCT / Capilano University)
Dr Izak Smit (SANParks)
Dr Stephanie Payne (U. Pretoria)
Dr Rita Covas (U. Porto, UCT)

Students: Shannon Conradie (PhD, Pretoria); Marc Freeman (PhD, Pretoria); Ryno Kemp (PhD, Pretoria); Benjamin Murphy (PhD, UCT); Celiwe Ngcamphalala (PhD, Pretoria); Matthew Noakes (PhD, Pretoria); Nicholas Pattinson (PhD, UCT); Michelle Thompson (PhD, Pretoria); Miqkayla Stofberg (PhD, UCT); Otto Makola (MSc, Pretoria); Jessica Roberts (MSc, Pretoria); Jaimie Whyte (MSc, Pretoria); Lara Strydom (M. Environ. Mgmt., Pretoria); Sean Morar (CB MSc, UCT); James Short (BSc Hons, Pretoria), Olivia Chalwin-Milton (BSc Hons, Pretoria).

Research Assistants: Lesedi Moagi, Jochen Voges, James Crossley, Amy Hunter, Justin Jacobs, Samantha Fourie.

Global change and urban birds

Urban environments create novel challenges and opportunities for birds. Understanding why and how some birds are able to adapt to urban landscapes, and others are 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 human life.

Red-winged Starlings *Onychognathus morio* have developed a reputation amongst the UCT community for being sly, lunch-thieving pests. 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 presence human days while in the nest showing reduced growth compared to those raised during lower human presence days. Miqkayla Stofberg's supplementary feeding experiment showed less clear morphological differences between nestlings fed different diets, but there were differences in their fatty acid profiles, with "junk food" chicks having lower omega-6, lower polyunsaturated fatty acid and higher saturated fatty acid blood profiles. Miqkayla's data also show that, while red-winged starlings increase panting and reduce foraging in response to hot temperatures on campus, this does not translate to changes in food intake rates or mass maintenance, suggesting that the abundant resources in the urban environment might buffer some impacts of heat stress. In 2021, two BSc honours students, Kagiso Nhlapo and Mila Truter, extended the scope of the starling work into stress physiology and cognition in relation to the birds' exposure to large numbers of people on campus daily.

Activities in 2021

- CB MSc student Varalika Jain submitted her thesis on the movement patterns of Ravens *Corvus corax* in the Austrian Alps in relation to anthropogenic food sources in the landscape, supervised by Petra Sumasgutner, Thomas Bugnyer, Matthias Loretto and Susie Cunningham. Vee graduated with Distinction and is currently writing up her results for publication.
- BSc Hons student Mila Truter conducted an experimental test of starlings' ability to recognise individual humans and categorise them as threatening, neutral or beneficial based on consistent differences in their behaviour. Mila showed that starlings can recognise both threatening and beneficial people and can generalise this recognition across different foraging contexts, approaching beneficial people more quickly than threatening people in all tested contexts. In addition, the birds were able to recognise people both with and without colour-coded t-shirts, suggesting that they can remember human individuals regardless of changes of clothing. This ability to remember and categorise different individual humans should carry fitness benefits for urban birds by improving foraging efficiency and reducing risk. Mila is working on writing up her findings for publication.
- BSc Hons student Kagiso Nhlapo experimentally validated that glucocorticoid metabolites in starling droppings reflect changes in circulating corticosterone in the birds, allowing completely non-invasive measurement of this stress biomarker in future studies with this species. Preliminary results from faecal samples collected on campus suggest that the birds might be less stressed when there are more people around, perhaps because of a greater availability of anthropogenic food and/or reduced predation risk (other predators may be deterred by human presence). In addition, these samples suggest that the starlings' degree of familiarity with the individual researchers following them can influence circulating cortocosterone – an intriguing finding that reflects Mila's results and requires further investigation. Kagiso will write up his findings for publication in 2022.
- Body mass maintenance and breeding monitoring continued throughout 2021: these data will be used to investigate the effects of the COVID-19 pandemic and fluctuating numbers of people and availability of human food.

Weighing and measuring Red-winged Starling nestlings (Photos: Susie Cunningham).

Highlights:

- 2020 BSc Hons student Taylyn Risi published a paper in a special issue of *Ostrich* on urban birds, showing that heavier and bigger starlings occupy more built-up home ranges on campus and that there was a five-fold difference in the availability of anthropogenic food discards on campus on weekdays compared to weekends pre-pandemic.
- The PAN-Environment Working Group, an international team of >300 authors including members of the Red-winged Starling team, published a paper assessing the impact of humans on the biosphere by comparing datasets collected before, during and after COVID lockdown measures.
- Former CB MSc student Sarah Catto published a paper on adult and nestling starling responses to high and low human presence days in the journal *Oecologia*.
- Dr Celiwe Ngcamphalala joined the team to lead stress physiology research.

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.

Key co-supporters

DSI-NRF CoE grant; NRF-STINT South Africa-Sweden Research Collaboration; NRF ACESS grant.

Research team 2021

A/Prof. Arjun Amar (FIAO, UCT)
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Dr Pippin Anderson (EGS, UCT)
Dr Martin Andersson (MEEL, Lund University)
Dr Thomas Bugnyer (KLF, University of Vienna)
Dr Susan Cunningham (FIAO, UCT)
Dr Celiwe Ngamphalala (BioSci, UCT)
Dr Arne Hegemann (MEEL, Lund University)
Dr Sally Hofmeyr (FIAO, UCT)
A/Prof. Caroline Isaksson (MEEL, Lund University)
Dr Matthias Loretto (Max Planck Institute of Animal Behaviour, Germany)
Dr Johan Nilsson (OIKOS office, Lund University)
Dr Petra Sumasgutner (KLF, University of Vienna)
Dr Robert Thomson (FIAO, UCT)
Dr Hannah Watson (MEEL, Lund University)

Students: Miqkayla Stofberg (PhD, UCT); Jessleena Suri (PhD, UCT); Varalika Jain (CB MSc, UCT); Kagiso Nhlapo (BSc Hons, UCT); Mila Truter (BSc Hons, UCT).

Volunteers: Mila Truter, Chima Nwaogu, Emmanuel Adekola, Emma Swann, Carla du Toit, Rowan Hickman, Jono Plaistowe, Timothy Aikins, Anthony Lowney, Bukola Azaki and many others.

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' species, and aims to understand what impacts these changes might have for other biodiversity.

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. Recently, 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. 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. To test this idea, we are exploring whether nesting densities or breeding demography differ depending on proximity to roads of different types (tar or gravel) and their associated levels of road kills. Our research is focussed in the Hantam Karoo (Succulent Karoo), where crow densities are known to have increased substantially.

Activities in 2021

- Temitope Abisoye and Kyle Walker drove road transects throughout the Karoo collecting data on road-kill and Pied Crow abundance. This work added broad spatial data to be used in conjunction with long-term temporal data previously collected by Rona van der Merwe.

Highlights

- Angela Ferguson's MSc thesis was published in the *Journal for Nature Conservation*. The paper, with co-authors Tom Flower and Robert Thomson, tested the efficacy of using conditioned food aversion to decrease pied crow predation on plover nests in the Berg River IBA. The paper also provides a detailed framework for CFA trials, aimed at avoiding potential pitfalls.

Conducting road transects means most of your fieldwork is in a car; here Temitope Abisoye (right) and Kyle Walker (left) set off for a day of documenting roadkill and counting crows (Photo: Kyle Walker).

Impact of the project

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

Key co-supporters

DST-NRF CoE grant; Mastercard Foundation.

Research team 2021

Dr Robert Thomson (FIAO, UCT)
A/Prof. Arjun Amar (FIAO, UCT)
Rona van der Merwe
Angela Ferguson
Dr Thomas Flower (FIAO, UCT / Capilano University)

Students: Temitope Abisoye (MSc, UCT).

Research Assistant: Kyle Walker.

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 provide indicators 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. It

Water bottle lids collected from 50m of beach at Rattray Point, a remote site in a private protected area in central Mozambique, sorted by brand. More than 80% are Danone Aqua lids from Indonesia (far left), and apart from one Tanzanian brand and one Chinese brand, all the other top ten brands came from Indonesia, indicating the long-distance drift of HDPE plastic items across the Indian Ocean in the South Equatorial Current (Photo: Peter Ryan).

Large amounts of plastic litter stranded on Vize Island in the central Kara Sea, between Franz Josef Land and Severnaya Zemlya, shows the extensive input of plastic from the North Atlantic into the Arctic. Litter from 19 countries was found on beaches during the Arctic Centenary Expedition to the Russian Arctic (Photo: Peter Ryan).

is planned to use this project to identify key sites for the installation of additional litter traps to reduce the release of land-based litter into the sea.

Activities in 2021

- Kyle Maclean started his MSc on the amounts of litter intercepted and the efficacy of different designs used to trap litter in rivers and storm drains. The first step was to produce an inventory of litter interception devices currently deployed on South African rivers, particularly in coastal areas. He then started monitoring litter trapped by various interception devices on two catchments in Cape Town. This was linked to estimates of the amounts and types of street litter in different land-use types in the respective catchment areas, which formed the basis of Emily Spencer's MSc. Unfortunately Emily withdrew from the project at the end of 2021 for personal reasons, but her sampling has been continued by project assistant Melissa Rankin.
- The litter trap project has forged valuable links with several other projects. Kyle is working part-time for The Litterboom Project, an NGO which deploys floating booms on several rivers in Cape Town and Durban. He is also supervising data collection for a collaborative project with TU Delft from the Netherlands using a water level gauge and time-lapse cameras to monitor litter caught by booms on the Liesbeek River. We are also working with Neil Armitage, from UCT's Faculty of Engineering and the Built Environment, and his MSc student Michael Jones, to compare litter retention by booms and nets on a canalised river entering the Marina da Gama, at Zandvlei. Finally, we have teamed up with Sarah Davies from Shark Spotters to monitor street and river litter in Ocean View, a low-income area on the southern Cape Peninsula, where litter loads previously were estimated in the 1990s.
- Peter Ryan was invited to participate in the Arctic Century Expedition to celebrate the centenary of the Russian Arctic and Antarctic Research Institute. He collected data on floating litter at sea as well as litter stranded on beaches in the Bering, Kara and Laptev Seas.
- Peter also sampled bottles and lid litter on three beaches in central Mozambique in November 2021: one urban beach, one 'resort' beach and one remote beach, to compare with similar data from Kenya and South Africa. Bottle and lid collections also continued every 2-3 months (COVID permitting) at two beaches near Cape Town and two near Port Elizabeth, to compare how repeated sampling compares to one-off sampling for inferring the age of beach litter.
- We monitored the use of plastic and other litter as sunshades by Cape Urchins *Parechinus angulosus* every spring low tide at a study site near Kalk Bay, where urchins use plastic much more than all other sites sampled around the Cape Peninsula. Sampling stopped in August 2021, after a full year of data collection.
- Vonica Perold took an extended leave of absence from her PhD on seabird plastic ingestion from September 2020 to take up a field position on Gough Island as part of the Gough Island Restoration Programme. She will only return to her studies at the end of 2022.

Highlights:

- Seven papers were published in 2021, including a paper led by Peter Ryan in *Environmental Pollution* showing the origin of bottle litter around the South African coast. Maëlle Connan from NMU led on a paper in *Marine Pollution Bulletin* on the distribution and abundance of litter at sea in the southwest Indian Ocean.
- Kyle Maclean published his honours project in *Marine Pollution Bulletin* on the dispersal of floating litter entering the sea from three South

A litter boom traps a large amount of floating litter above a series of nets installed to catch litter on a canalised stream entering Marina da Gama, Zandvlei (Photo: Peter Ryan).

African rivers. This built on a paper in *Estuarine, Coastal and Shelf Science* by Peter Ryan and Vonica Perold showing limited dispersal of litter from a river entering False Bay based on data collected during the 2020 COVID beach closures.

- Peter Ryan and Ben Dilley were co-authors on a paper showing the presence of UV-stabilisers in seabirds derived from the plastics they ingest (*Environmental Monitoring and Contaminants Research*). The presence of high concentrations of UV-238 in Blue Petrels sampled on Marion Island provides compelling evidence that plastic is responsible for the long-distance transport of this POP, because the Blue Petrel seldom ventures north of the Antarctic Polar Front. Despite these waters having the lowest concentrations of floating plastics on Earth, more than 80% of Blue Petrels typically contain ingested plastic. This finding is crucial to have this compound banned under the Stockholm Convention.
- Peter and former MSc student Eleanor Weideman teamed up with Martin Thiel and Daniela Honorato from Chile to review marine plastic pollution in the Western Indian Ocean region. In addition to the main report, an abridged version will be published in *Oceanography and Marine Biology: an Annual Review* in 2022.
- Peter was invited to join the fourth phase of the United Nation's GESAMP Working Group 40 on the sources, fate and effects of marine plastics.
- Our lab has been given a new FTIR spectrophotometer to identify plastic samples, which should arrive in early 2022.

Key co-supporters

Plastics SA; 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; WIOMSA.

Research team 2021

Prof. Peter Ryan (FIAO, UCT)
A/Prof. Coleen Moloney (Biological Sciences, UCT)
Dr Maëlle Connan (NMU)
Dr Patrick O'Farrell (FIAO, UCT)
Aaniyah Omardien (The Beach Co-op)

Students: Vonica Perold (PhD, UCT); Kyle Maclean (MSc, UCT); Emily Spencer (MSc, UCT)

Assistants and volunteers: Melissa Rankin and the Dalebrook 'urchin team'.

Detecting aliens from space

Biological invasions are responsible for some of the most devastating impacts on the world's ecosystems. Freshwater ecosystems are among the worst affected, with biological invasion posing serious threats not only to freshwater biodiversity, but to the important ecosystem services it provides. Tackling the impact of these invaders on our freshwater ecosystems is currently a major challenge, and one that requires detailed information on both invasive species distribution and spread. While these concerns are relevant globally, there is an urgent need to conduct research of this nature in countries such as South Africa, where freshwater resources are becoming increasingly pressured.

This project utilises freely available satellite data and the processing capabilities of cloud computing platforms to map the distribution of the worst invasive aquatic alien plant, Water Hyacinth *Eichhornia crassipes* across South African waterbodies to explore reasons for its occurrence and identify optimal biological control release strategies. PhD student Geethen Singh is undertaking this valuable research in collaboration with Chevonne Reynolds, Benjamin Rosman and Marcus Byrne of the University of the Witwatersrand.

Invasive aquatic alien plant species present a serious threat to South Africa's freshwater resources as they increase water loss through evapotranspiration. Water weeds can increase water loss by 130–180%. Water body area and the percentage cover of invasive aquatic weeds on these impoundments are crucial information needed to facilitate the removal and management of these weeds. However, field assessments to obtain this information are often too time-consuming, costly and labour intensive. Freely available satellite images are an alternative and cost-effective approach to reliably and frequently assess the coverage of surface water weeds. In this way, the extent of water weed infestation and its associated drivers can be identified and tracked.

Once an invasive alien species has established itself it can be difficult or even impossible to stop or slow down the invasion. Thus, the early and rapid detection of invasive alien species is needed to make management targeted, feasible and effective. Consequently, there is an urgent need for techniques that enable consistent, fast and accurate monitoring. This will allow invasion biologists to systematically monitor invasive alien species over the introduction, establishment and secondary dispersal phases of the invasion process, across large areas with a reduced risk of accidental invasive alien plant dispersal by field personnel. Geethen is making use of semi-automated satellite image analysis techniques, such as semantic segmentation of freely available Landsat, Sentinel-1 and Sentinel-2 imagery to map the distribution of water hyacinth at a national level.

Furthermore, Geethen is undertaking this analysis within Google Earth Engine, a cloud computing platform that allows scientists and managers the ability to produce up-to-date maps of surface water extent and percentage plant cover.

Activities in 2021

- Over the last year, Geethen has made excellent progress in identifying the dominant factors determining the occurrence of water hyacinth at a national level and has put together a framework that can be used to identify candidate biocontrol release strategies. In the coming months, Geethen will make the products readily accessible and adoptable by scientists and the general public in an effort to aid the management of aquatic weeds across the country.
- Geethen presented three courses on ecological applications in Google Earth Engine.
- Geethen delivered a GIS course to honours students at the University of the Witwatersrand.
- Geethen delivered a hands-on tutorial on using Google Earth Engine data for machine learning at the Deep Learning Indaba X 2021.

Water Hyacinth infestation at Hartbeespoort Dam in Johannesburg.

Megamelus scutellaris biocontrol agents feeding on water hyacinth (Photos: Geethen Singh).

Highlights:

- Geethen is preparing to submit his PhD thesis.
- Geethen will spend three weeks conducting research at the Norwegian Institute for Nature Research and give a one-day Google Earth Engine workshop to participants from the University of Oslo.

Key co-supporters

DSi-NRF CoE grant.

Research team 2021

Dr Chevonne Reynolds (APES, Wits)
Dr Benjamin Rosman (Applied Maths, Wits)
Prof. Marcus Byrne (APES, Wits)
Student: Geethen Singh (PhD, Wits)

Conservation Biology Masters programme 2021

The 2021 intake of CB students comprised 14 students from six countries: South Africa, Botswana, Uganda, Mozambique, the UK, Norway and Zimbabwe. The South African contingent represented a slightly higher proportion of the class than usual (~60% up from 40-50% in a 'normal' year), due to the ongoing pandemic and travel concerns for international students. To increase the probability that we would be able to teach the course face-to-face in 2021, we shifted the start date of the course to 17 May 2021. Students completed their coursework in December and are currently engaged in the research components of their degrees, with a hand-in deadline in July 2022. At the time of writing, the 2022 cohort has already begun their coursework on the normal timetable, meaning a much greater overlap between cohorts than usual.

Course structure and teachers

The course continues to be taught by a wide range of module leaders from within and outside UCT. In 2021, the module leaders were: Arjun Amar (Statistical Analyses); Denham Parker (Marine Conservation – standing in for Colin Attwood on sabbatical); Jacqui Bishop (Conservation Genetics); Susie Cunningham (Biodiversity Basics); David Cumming (Big Picture and Philosophy of Science); Wendy Foden (Conservation Leadership); Dalton Gibbs (Urban Ecology and Conservation); Lindsey Gilson (Climate Change); Vincent Naude (Conservation in Practice, standing in for Justin O'Riain on sabbatical); Patrick O'Farrell (Landscape Ecology and GIS); Sebataolo Rahlao and John Hoffman (Invasion Ecology); Peter Ryan (Demography and PVA); Jeremy Shelton (Freshwater Conservation); Claire Spottiswoode (Project Planning); Gladman Thondhlana (Conservation and Society); Robert Thomson and Timm Hoffman (Community Ecology); and Jane Turpie (Resource Economics). In addition, many others contribute through guest lectures, field trips and discussions. This diversity of perspectives adds greatly to the course.

Challenges and opportunities

Social distancing requirements in combination with the UCT fire meant we were unable to teach the 2021 cohort in the new CB MSc lab in the H.W. Pearson building. Instead, the Computer Science Department kindly allowed us to use space in their building. Teaching had a different flavour from usual, with student desks set up as immovable "islands" 2 m apart. Lectures and discussion sessions under these conditions were challenging, especially as masks had to be worn at all times. Constantly open windows created challenging conditions for comfort, especially in winter. Despite this, the class pulled together with good cheer and made the coursework a success.

Shifting the start date of the course was a partial success in terms of allowing face-to-face teaching. Several times throughout the year we were forced to move all teaching online as we navigated COVID-19 outbreaks and government lockdowns. Hardest of all was the Delta wave and associated lockdown, during which a handful of students became badly ill shortly prior to their age group becoming eligible for vaccination. Nevertheless, all pulled through and completed the coursework successfully (some even attended class on Zoom from their sickbed!).

Highlights

- Research carried out by CB MSc students for their dissertations continues to produce publication-quality results. In 2021, four papers from CB projects were published in international journals. We are excited that our CB students' research is being disseminated widely and can improve conservation outcomes in Africa and globally.
- All 14 of the 2021 cohort of students completed the coursework component of the degree despite another year of very trying pandemic conditions. Nine students achieved distinctions for their coursework.

Orientation week hike and picnic (Photo: Callan Cohen).

MSc Conservation Biology projects 2021

Candice Denner: The socio-economic contributions of wildlife ranching in the Eastern Cape, South Africa. Supervisors: Alta de Vos, Hayley Clements, Timm Hoffman, Matthew Child.

Jane Doherty: Does the Karoo population of Martial Eagles have the potential to buffer the species' national decline? Supervisors: Gareth Tate, Arjun Amar.

Nicola du Plessis: Investigating households' willingness to pay for a secure and sustainable water supply. Supervisors: Jane Turpie, Martine Viljoen, Pippin Anderson.

Sara Forsberg: Disentangling entanglement in Cape fur seals (*Arctocephalus pusillus pusillus*) for better management of plastic pollution impacts. Supervisor: Peter Ryan.

Ricardo Guta: Phylogeography of flightless spring katydids (Tettigoniidae: *Brinckiella*) in Greater Cape Floristic Region. Supervisors: Charlene Janion-Scheepers, Piotr Naskrecki.

Johanna Hawker: Among elephants: riverine vegetation impacts in Gonarezhou National Park, Zimbabwe. Supervisors: Tim O'Connor, Timm Hoffman.

Kyle Hinde: Population and driving factors of density variation of Leopards in the Overberg. Supervisors: Justin O'Riain, Katherine Williams.

Sean Morar: Beating the heat: keeping water available for birds of the Tankwa Karoo desert. Supervisors: Susan Cunningham, Wendy Foden, Nicola Wilgen, Alan Lee.

Charles Mpofu: Using GPS tracking data to explore diet of African Vultures in Botswana. Supervisors: Arjun Amar, Gareth Tate, Glyn Maude.

Kim Parker: Caracals as sentinels for heavy metal exposure in human-transformed landscapes. Supervisors: Gabriella Leighton, Jacqueline Bishop.

Joseph Sekyanzi: In-depth analysis of poisoning and belief-based use as main threats to vultures in pastoral areas of Southern Kenya. Supervisors: Robert Thomson, Andrea Santangeli

Nomasonto Skosana: Using benthic algae as an indicator of recreational disturbance in Langebaan lagoon. Supervisor: Deena Pillay.

Kayla Webster: Understanding water service providers' perspectives of catchment conservation as a means to secure water-related ecosystem services. Supervisors: Jane Turpie, Martine Visser, Sheona Shackleton.

Emma Wright: A remote sensing evaluation of cape parrot habitat change in the Eastern Cape: implications for conservation. Supervisors: Vernon Visser, Timm Hoffman.

Members of the CB MSc class of 2021 attending class on Zoom during the Delta wave of COVID-19 (Photo: Jane Turpie).

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 Friday teas, meetings, seminars, the annual general meeting, and occasional classes.

Introduction

After a somewhat frustrating year in 2020 of limited access to campus, forcing the suspension of some library tasks, the latter half of 2021 began to show some promise of a return to "normality".

At the beginning of the year, access to campus was still limited and the librarian was able to go to the office once a week to fill SAFRING orders and complete essential tasks. Thereafter, with the gradual easing of COVID-19 restrictions, campus began to see more activity than it had during 2020, and visits to the library were more frequent. Library visitors increased and most tasks that had been put on hold during 2020 were resumed.

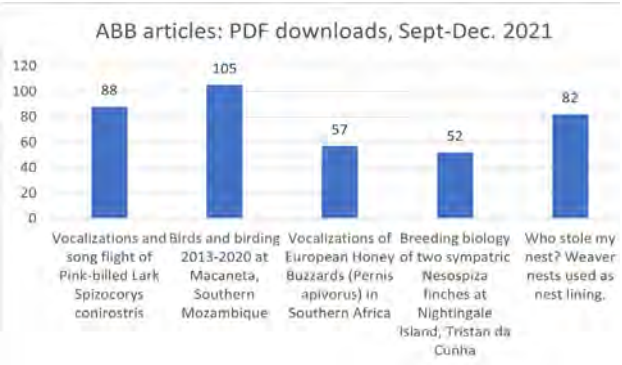
"2020, the sequel?"

Both the UCT campus and the Niven were quiet during the first semester – a very similar scenario to the previous year. However, the Librarian saw to it that restricted visitor access to campus didn't hinder operations and met with Library and Fitz visitors at alternative venues off campus. These included SAFRING customers, who had ordered bird rings and chose to collect them rather than have them sent via post or courier, and Fitz book sale customers who had chosen books online but were unable to fetch them from the library.

Limited access to campus also resulted in another bumper year of information requests. More than 230 files were sent to local and international researchers who requested information contained in Niven library material, both hard copy and digital.

Back to "normal"

In 2020, the COVID-19 lockdown resulted in global postal restrictions and delays. Consequently, a massive accumulation of journals, newsletters, books, and other library material that had been posted to the Niven during the previous year arrived at the beginning of 2021.



Number of downloads of papers published in the journal *Afrotropical Bird Biology*, Sept. to Dec. 2021

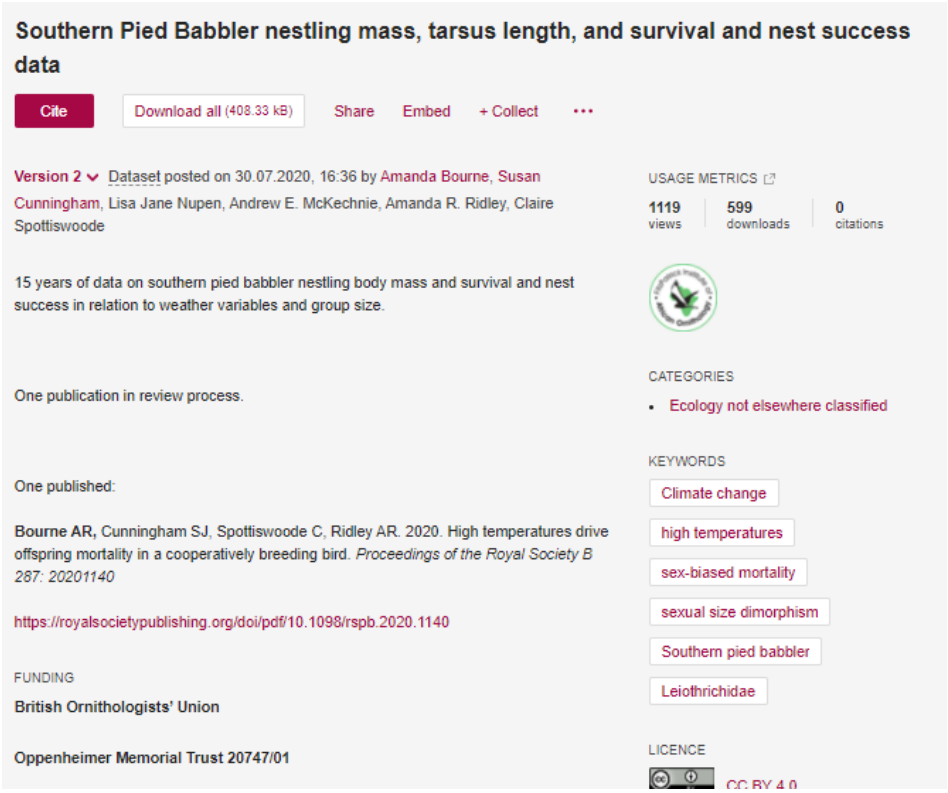
Processing began as soon as the material arrived, and it was once again possible to copy contents pages and alert staff and students to new material that was available for browsing in the library. While only a few took advantage of this opportunity, some chose to request copies of papers listed in these messages.

Most journal and newsletter titles are now up to date, but a considerable and ongoing task has been following up on missing issues to ensure that the collection is complete.

Another indication of a return to the way things were pre-COVID-19 was the resumption this year of face-to-face library orientation sessions with the new MSc Conservation Biology students. COVID-19 rules dictated that, to maintain social distancing, no more than ten people could be in the library at a time. The class was therefore split into two and an orientation session was held in the library for one group, while the other attended an online introductory session with UCT Library's Science librarian.

Research data on ZivaHub

This year, the librarian added the Biological Sciences department to her existing role of ZivaHub submissions moderator for the Fitz. This role involves helping researchers with their



Southern Pied Babbler nestling mass, tarsus length, and survival and nest success data

Cite | Download all (408.33 kB) | Share | Embed | + Collect | •••

Version 2 Dataset posted on 30.07.2020, 16:36 by Amanda Bourne, Susan Cunningham, Lisa Jane Nupen, Andrew E. McKechnie, Amanda R. Ridley, Claire Spottiswoode

15 years of data on southern pied babbler nestling body mass and survival and nest success in relation to weather variables and group size.

One publication in review process.

One published:

Bourne AR, Cunningham SJ, Spottiswoode C, Ridley AR. 2020. High temperatures drive offspring mortality in a cooperatively breeding bird. *Proceedings of the Royal Society B 287: 20201140*

https://royalsocietypublishing.org/doi/pdf/10.1098/rspb.2020.1140

FUNDING

British Ornithologists' Union

Oppenheimer Memorial Trust 20747/01

USAGE METRICS

1119 views | 599 downloads | 0 citations

CATEGORIES

- Ecology not elsewhere classified

KEYWORDS

Climate change | high temperatures | sex-biased mortality | sexual size dimorphism | Southern pied babbler | Leiothrichidae

LICENCE

CC BY 4.0

Amanda Bourne's submission to ZivaHub, Southern Pied Babbler nestling mass https://doi.org/10.25375/uct.12441899.v2, was downloaded 599 times in 2021.

submissions to the university's online research data repository, as well as moderating and publishing them.

To date, the department has 104 datasets on ZivaHub, 32 of which were submitted by Fitz researchers. These 32 datasets received 6354 views in 2021 and were downloaded 6259 times.

Topping the Fitz submissions charts with the most views at 1426 is Joshua Weiss's "Spatio-temporal changes in riparian woodlands of the Kruger National Park: drivers and implications".

The dataset with the most downloads this year (599) was uploaded by Amanda Bourne: "Southern Pied Babbler nestling mass, tarsus length, and survival and nest success data".

Overall, datasets uploaded by the Biological Sciences department received 14761 views and 12708 downloads.

***Bulletin of the African Bird Club* - one of the 2020 journal issues**

Afrotropical Bird Biology launched

With the librarian as journal manager, September saw the launch of *Afrotropical Bird Biology: Journal of the Natural History of African Birds* (ABB), with five research papers and one short communication:

- Vocalizations and song flight of Pink-billed Lark Spizocorys conirostris
- Birds and birding 2013-2020 at Macaneta, Southern Mozambique
- Vocalizations of European Honey Buzzards (Pernis apivorus) in Southern Africa
- Breeding biology of two sympatric Nesospiza finches at Nightingale Island, Tristan da Cunha
- Who stole my nest? Weaver nests used as nest lining.

Another paper, Opportunistic avian nectarivory on flowering Aloe maculata with a review of visiting bird species, was added in December.

From the launch until the end of the year, these papers were downloaded 418 times in total.

The journal was given an ISSN in November: ISSN: 2790-0592 and continues to receive regular submissions.

Niven Library Staff 2021
Janine Dunlop (Niven Librarian)

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.

About 165 bird ringers were active during 2021, and additional ringers that were not active in 2021 continue to submit data. Demand for rings was high and SAFRING received stock of several thousand new rings from orders made in 2020; in addition, new rings were ordered and partially received during the year.

Although Kim-Kelly Hunt's NRF-funded internship with SAFRING ended in March 2021, she had made herself indispensable and was therefore appointed part-time as SAFRING Research/Data manager. Kim assists ringers with data uploads and responds to recovery or resighting reports from members of the public and leads the collation and extraction of data used by researchers for papers and reports.

A key achievement for the year was the establishment of a SAFRING Steering committee 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 departments, and ringers with special interests, such as bird rehabilitation.

Social media

Facebook changed some of the rules governing groups in 2021 so it was decided to change the setting from a private to a public group, which allowed anyone to join without requiring moderation from the page administrator. The change had a positive impact: 78 more people joined the SAFRING Facebook group over the past year and 185 posts were added, by both SAFRING administrators and group members, receiving 1787 reactions and 391 comments. The most popular post was one by Rina Pretorius, who posted about the retrap of a Barn Swallow L67856, ringed at Amcor Dam, Newcastle in 2016 and retrapped 4 years, 10 months later in Lithuania.

Our Twitter account had 26 posts, a mixture of SAFRING news, retweets of interesting posts found on other organisations' profiles, and information about bird ringing. By far, the most popular and interesting post was about the source of ring P122, that had been found, without the bird, in Mazeppa Bay on the Transkei coast, and reported to us. Our query was posted on 17 August and went around the world a few times, from South Africa, to the UK, to Europe, and to Canada. It was eventually identified a month later as a ring used on an Arctic Tern by the U.S. Fish and Wildlife Service in Maine, USA.

Activities in 2021

- Robert presented a talk to the EURING General Assembly, which introduced SAFRING and provided an update of bird ringing activities currently in South Africa and large parts of Africa.
- SAFRING participated in the 'Banders Without Borders' initiative hosted by the USGS Bird Banding Lab (BBL). Joined by the Canadian Bird Banding Office (BBO), the schemes provided introductions and updates, with a nice exchange of ideas to collaborate in the future.

African Sacred Ibis *Threskiornis aethiopicus*. This photo by Amber Lee, taken in Howick on 6 Mar 21, was posted on the SAFRING Facebook group. It was identified by Tammy Caine as a rehabilitated bird released by FreeMe Wildlife.

SAFRING team 2021

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

2021 was a year of recovery across all walks of life, including SABAP2. Having felt the effect of the COVID-19 lockdown in 2019 and 2020, 2021 was met with renewed growth and enthusiasm from our team of observers. A total of 26 163 full protocol cards, containing 1.8 million records were submitted during 2021, covering 5 171 pentads. These observations were made by 926 dedicated observers, who put in a record-breaking 92 000 hours of field work during 2021!

Two significant milestones were passed during the year, and along with new funding and the recruitment of new observers, the future is looking positive. During 2021 the project passed 300 000 full protocol cards submissions, and 1 million hours of full protocol fieldwork. These two milestones are testament to the dedication of our citizen science volunteers.

There was also much to be celebrated on the funding front. SABAP2, through the African Bird Atlas Project (ABAP), was able to secure two-years of partial funding through a GBIF BID grant, aimed at growing the ABAP project throughout Africa and mobilising ABAP data for wider use. SABAP2 forms the southern node of this project, with Nigeria and Kenya being the western and eastern nodes, respectively. This project, led by Dr Sam Ivande of APLORI in Nigeria, aims to implement the BirdMap protocol, which was developed in SABAP2, across the continent. The Fitz will host the information systems for ABAP. We are extremely grateful to Dr Chris Brown from the Namibian Chamber of the Environment for facilitating funding for the southern African node.

Further funding was secured through the BIRDIE project, a JRS-funded initiative by UCT's Centre for Statistics in Ecology, the Environment and Conservation (SEEC), SANBI and the Fitz. This project will use SABAP2 and Coordinated Waterbird Count (CWAC) data to create a set of tools and analysis products that will help guide policy development in near real time.

These funds, along with generous funding from the Rupert Foundation, the Isdell Family Foundation, SANBI, bird clubs and private sponsors, have allowed SABAP2 to continue through 2021 into 2022. However, we still need to secure funding beyond the end of 2022.

Nine papers were added to the growing list of work published using SABAP2 data during 2021, which can be found at http://sabap2.birdmap.africa/media/bibliography#pgcontent.

SABAP2 team (Admin)

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Sanjo Rose (Project Communications, FIAO)
Michael Brooks (Information Systems Specialist, FIAO)

SABAP2 team (Regional Atlas Committees)

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Bob Medland, Malawi
Rick Nuttal, Free State
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Garret Skead, Western Cape
Dave Winter, Western Cape
Chris Brewster, Botswana
Andrew de Blocq, Western Cape
Derek Engelbreght, Limpopo
Gerrie Horne, Eastern Cape
Holger Kolberg, Namibia
Etienne Marais, Mozambique
Duncan McKenzie, Mpumalanga
Ara Monadjem, Eswatini
Vincent Parker, Northern Cape
Ian Riddell, Zimbabwe
Colin Summersgill, KZN

Scientific publications 2021

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)

Final Journal Published Papers

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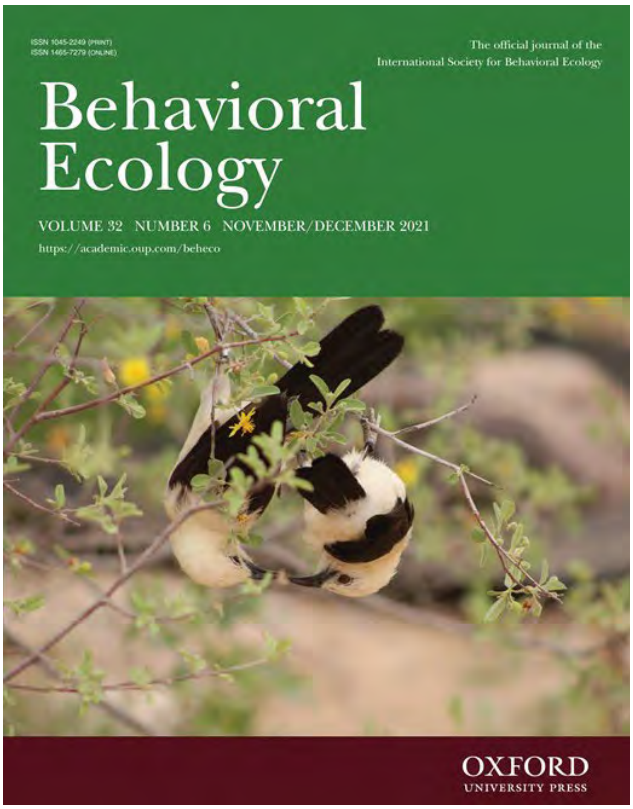

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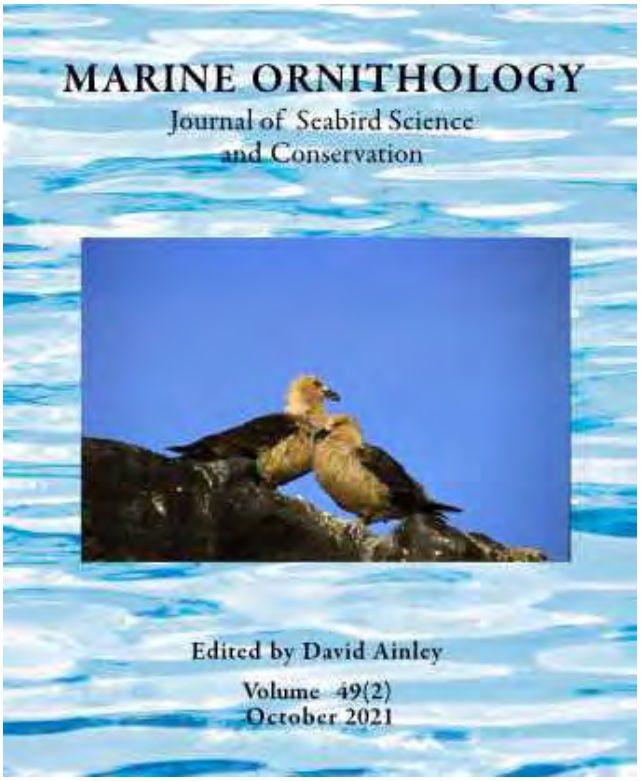

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Fitz staff, students and associates regularly contribute popular articles to BirdLife SA's bi-monthly publication *African Birdlife*.

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