FitzPatrick Institute of African Ornithology

DST-NRF Centre of Excellence

University of Cape Town

Annual Report 2017

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Centre of Excellence Board 2017

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FRONT COVER: **Southern Ground-Hornbill (Photo: Peter Ryan).**

REPORT LAYOUT: HILARY BUCHANAN

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Director's Report

Peter Ryan (Photo: Claire Spottiswoode)

2017 was another productive year for the Fitz, with the Centre of Excellence (CoE) publishing 132 peer-reviewed publications, two books, five book chapters and 57 popular articles. Numbers of scientific papers were down slightly compared to the bumper years of 2015 and 2016, but this is likely due to the cyclical nature of research programmes rather than any drop off in research effort. Certainly the Fitz staff remain as busy and committed as ever. As has become the norm, many research projects were featured in the print media, on radio and TV programmes, and Arjun Amar in particular has ensured that the Fitz continues to grow its presence on social media.

2017 also saw a large number of postgraduate students have their degrees awarded, with seven PhDs: Kate Carstens, Davide Gaglio, Sophie Garcia-Heras, Dominic Rollinson, Tanja van de Ven, Rowen van Eeden and Otto Whitehead. Andrew de Blocq was awarded an MSc by dissertation, and 13 conservation biology (CB) MSc students graduated: Huyam Abbas, Michelle Blanckenberg, Sarah Casola, Tendai Chinho, Christie Craig, Carles Durà, Wesley Gush, Corey Jeal, Alicia Ly, Matthew Macray, Elelwani Nenzhelele, Ryan Olinger and Margaret Parrish. Congratulations to them all, as well as to Fitz CoE-supported students based at other institutions: Rabi'a Ryklief was awarded her PhD and Jonathan Botha, Jerry Molepo and Danielle van den Heever all received MScs from Nelson Mandela University (NMU). Honours students supported by the CoE included Alexis Osborne (UCT), Nevanya Lubbe (Pretoria) and Abigail Ramudzuli (Limpopo).

The winter student intern programme once again brought students from Limpopo University to UCT for three weeks in June 2017. Honours student Abigail Ramudzuli returned for a second year, accompanied by under-graduates Clementine Malatji, Helga Chauke and Thato Mashigo. Abigail also accompanied postdoc Dayo Osinubi at the end of 2017 on one of his many field trips to study intra-African migrants, and will register at UCT for an MSc in 2018.

Fitz students continued to excel, with Tanja van de Ven taking first prize for a student presentation at the Zoological Society of Southern Africa Conference, Dayo Osinubi received the best post-doc oral presentation at the 8th Annual Research Symposium of the National Zoological Gardens of South Africa, and Gabriella Leighton receiving the British Ecological Society's Robert May Prize for the best paper by an Early Career Researcher in *Methods in Ecology and Evolution* for the work arising from her honours project with Arjun Amar. Margaux Rat was invited to give the Christer Hemborg Lecture at the Evolutionary Biology Centre, University of Uppsala, and Gareth Tate received the Purcell Memorial Prize for the best thesis in Biological Sciences at UCT.

Claire Spottiswoode received the Bicentenary Medal of the Linnaean Society of London for "excellent work done by a scientist under the age of 40 years" and the Scientific Medal of the Zoological Society of London for "distinguished work in Zoology by a scientist with up to 15 years postdoctoral experience". Peter Ryan was awarded the Gilchrist Medal for contributions to marine science and was elected a Fellow of UCT. Arjun Amar was promoted *ad hominem* to Associate Professor from the start of 2018. Perhaps most exciting, however, was former PhD student Chevonne Reynolds' appointment to a teaching position at the University of the Witwatersrand. Chevonne will continue to work closely with the Fitz CoE, establishing a node with a new South African partner institution.

On the Fitz staffing front, we were very pleased to consolidate the current academic staff structure by extending Susie Cunningham's appointment to a permanent contract position. This gives Susie security of tenure, although it remains the Fitz's responsibility to ensure there are sufficient funds to meet her post costs each year. Currently half of the position is carried by the CoE, and the other half by UCT's obligatory support towards the CoE. Given her pivotal role in running the CB masters course, I am confident we'll find the necessary funds should the CoE end after the current five-year cycle.

The future of the CoE remains uncertain. At a meeting with the Department of Science and Technology (DST) and the National Research Foundation (NRF) in August 2017 we were tasked with producing a 'vision' for the future that considered expanding the CoE. However, following discussion with UCT's DVC Research, other officials from UCT's Research Office, and the Dean of Science, we concluded that the present structure of the FitzPatrick Institute CoE is close to optimum. In the current financial climate, when South Africa is struggling to maintain current R&D investment, there is little scope to expand existing research investment. There is also increasing pressure to focus government-funded research on subjects with immediate benefits in terms of employment and wealth creation.

Expanding the CoE's focus beyond birds would bring us into potential competition with other taxon-

specific institutes such as the South African Institute for Aquatic Biodiversity (SAIAB), as well as increasing overlap with the South African National Biodiversity Institute (SANBI), the entity tasked with assessing and monitoring biodiversity at a national level. We believe that the most efficient model is for the Fitz CoE to consolidate our key strength in ornithological research in collaboration with SANBI, BirdLife South Africa and other partners, and to help to set the research agenda at a broader, regional and even continental level. The CoE plays a key role in training future leaders in conservation science across Africa, and this capacity must be maintained.

The conclusion that the CoE should not seek to expand through increased DST-NRF funding does not mean that we lack ambition, or are content with the *status quo*. We shall strive to continue to grow both in terms of scope and relevance without recourse to increased DST-NRF direct support. Indeed during 2017, research funding from non-CoE sources doubled from R6 to R12 million. A major development from 2018 onwards will be the Fitz taking over the management of the Southern African Bird Atlas Project (SABAP) and various virtual museums in collaboration with SANBI, BLSA and BirdLasser as part of a plan to ensure the long-term sustainability of the databases currently managed by the Animal Demography Unit (ADU). This step will further strengthen links to partner organisations and increase the relevance and outreach of the Fitz, through the thousands of citizen scientists who contribute to these projects as well as users of the resultant data.

From 2018 the Fitz also will take back the running of SAFRING, the bird ringing scheme for much of Africa, further increasing our importance to the research and conservation community across the continent. I am grateful to Susan Mvungi, the Niven Librarian, for accepting the challenge of running SAFRING under the guidance of Robert Thomson. I am cognizant of the arguments made by then Director Roy Siegfried when the decision was taken to remove SAFRING from the Fitz some 30 years ago; many still apply, but it was a case of no-one else willing or able to step up and assume responsibility for this core support programme.

Peter Ryan, April 2018

BirdLife South Africa's second 'Flock at Sea' in April 2017 attracted close to 2000 birders. The cruise saw the launch of a fund-raising initiative to help cover the costs of the mouse eradication planned for Marion Island in 2020, as well as the release of a popular book on southern African seabirds by Peter Ryan (Photo: Peter Ryan).

Staff, Students and Associates

UCT GRADUATES

PhD
Marie-Sophie Garcia-Heras; Dominic Rollinson; Rowen van Eeden (June);
Kate Carstens, Davide Gaglio; Tanja van de Ven;, Otto Whitehead (Dec)

MSc
Andrew de Blocq (June)

Conservation Biology MSc
Michelle Blanckenberg, Sarah Casola, Christie Craig, Carles Durà, Wesley Gush, Corey Jeal, Alicia Ly, Matthew Macray, Elelwani Nenzhelele, Ryan Olinger, (June); Huyam Abbas, Tendai Chinho, Margaret Parrish (Dec)

NEW UCT STUDENTS

Post-doctoral fellows
Susan Miller (Peter Ryan)

PhD
Christiaan Brink (Robert Thomson), Carina Nebel (Arjun Amar); Stefan Schoombie (Peter Ryan)

MSc
Carla du Toit (Susan Cunningham); Chris Jones (Peter Ryan); Alexis Osborne (Peter Ryan); Rona van der Merwe (Arjun Amar)

Upgrade from MSc to PhD: Selena Flores

Conservation Biology MSc
Thirteen students began the CB MSc in January 2017.

BSc Hons
Billi Krochuk, Alexis Osborne, Sanjo Rose, Miqkayla Stofberg

Academic Staff

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

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

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

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

Honorary Research Associates
Dr Phoebe Barnard, PhD (Uppsala)
Dr Rita Covas, PhD (Cape Town)
Prof. Graeme Cumming, PhD (Oxford)
Dr Tom Flower, PhD (Cambridge)
Dr David Grémillet, PhD (Kiel)
Dr Kristi Maciejewski, PhD (NMMU)
Prof. Steven Redpath (PhD, Leeds)
Assoc. Prof. Mandy Ridley, PhD (Cambridge)
Dr Rob Simmons, PhD (Wits)
Dr Ross Wanless, PhD (Cape Town)

Honorary Research Affiliate
Dr Azwianewi Makhado, PhD (Cape Town)

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

Support Staff

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

Principal Technical Officer:
Gonzalo Aguilar

Administrative Assistant:
Hilary Buchanan BA, HDipLib (Cape Town)

Senior Secretary, DST-NRF CoE:
Denise Scheepers

Departmental/Accounts Assistant:
Anthea Links

Niven Librarian:
Susan Mvungi MSc (Cape Town)

Niven Library Assistant:
Phelisa Hans

Ad Hoc Research Assistants:
Amy Bruce, Christie Craig, Andrew de Blocq, Paige Ezzey, Campbell Fleming, Carrie Hickman, Sello Matjee, Shane McPherson, Kyle Middleton, Clement Motau, Christie Munro, Ryan Olinger, Dane Paijmans, Vonica Perold, Kervin Prayag, Stefan Schoombie, Lucy Smythe, Miqkayla Stofberg, Jessleena Suri, Eleanor Weideman, Kim Zoeller

Students

Post-doctoral fellows
Dr Diana Bolopo, PhD (Valladolid)
Dr Anina Coetzee, PhD (Stellenbosch)
Dr Susan Miller, PhD (TUT)
Dr Megan Murgatroyd, PhD (Cape Town)
Dr Dayo Osinubi, PhD (Christchurch)
Dr Margaux Rat, PhD (Cape Town)
Dr Chevonne Reynolds, PhD (Cape Town)
Dr Petra Sumasgutner, PhD (Vienna)

Doctoral
Amanda Bourne, MSc (Cape Town)
Christiaan Brink, MSc (Cape Town)
Kate Carstens, MSc (KwaZulu-Natal)
Daniël Cloete, MSc (Cape Town)
Ben Dilley, BSc (Hons) (Cape Town)
Selena Flores, BSc (San Diego)
Rebecca Garbett, BSc (Hons) (Kent)
Davide Gaglio, MSc (Bologna)
Marie-Sophie Garcia Heras, MSc (Aix-Marseilles)
Anthony Lowney, MSc (Manchester)
Carina Nebel, MSc (Vienna)
Dominic Rollinson, MSc (KwaZulu-Natal)
Stefan Schoombie, MSc (Cape Town)
Kim Stevens, BSc (Hons) (Cape Town)
Tanja van de Ven, MSc (NMMU)
Rowen van Eeden, MSc (Cape Town)
Otto Whitehead, BSc (Hons) (Cape Town)

MSc by dissertation
Andrew de Blocq, BSc (Hons) (Cape Town)
Campbell Fleming, BSc (Hons) (Cape Town)
Laurie Johnson, BSc (Hons) (Cape Town)
Chris Jones, BSc (Hons) (KwaZulu-Natal)
Luke McClean, BSc (Queens)
Kyle-Mark Middleton, BSc (Hons) (Pretoria)
Ditiro Moloto, BSc (Hons) (Limpopo)
Noelle Tubbs, BSc (Rhode Island)
Rona van der Merwe, BSc (Hons) (Stellenbosch)

Masters in Conservation Biology 2017/8
Rio Button, BSc (Hons) (Cape Town)
Sarah Catto, BSc (Hons) (Cape Town)
Sydney Davis, BSc (San Diego)
Shannon Dubay, BSc (James Madison)
Olli Hyvärinen, BSc (Hons) (Leiden)
Caitlin Kelly, BA (Virginia)
Leungo Leepile, BSc (Botswana)
Colleen Lindberg, BSc (Nebraska)
Oyena Masiko, BSc (Hons) (UNISA)
Franck Mavinga, BSc Eng (Brazzaville)
Phoebe Mottram, BSc (Hons) (St Andrews)
David van Beuningen, BSc (Hons) (Cape Town)
Tapiwa Zimunya, BSc (Hons) (Chinhoyi)

Masters in Conservation Biology 2016/17
Huyam Abbas, BSc Hons (Khartoum)
Michelle Blanckenberg, BSc Hons (Rhodes)
Sarah Casola, BSc (Ithaca)
Tendai Chinho, BSc Hons (NUST, Zimbabwe)
Christie Craig, BSc Hons (Cape Town)
Belinda Day, BSc Hons (Cape Town)
Carles Durà, BSc (U. Vic, Catalonia)
Wesley Gush, BSc Hons (Rhodes)
Corey Jeal, BSc (Deakin)
Alicia Ly, BSc Hons (Oregon)
Matthew Macray, BSc Hons (Cape Town)
Elelwani Nenzhelele, BSc Hons (Venda)
Ryan Olinger, BSc (Arizona)
Margaret Parrish, BA (Colby)

BSc Honours
Billi Krochuk, Alexis Osborne, Sanjo Rose, Miqkayla Stofberg

Externally registered students

Postdoctoral fellow:
NMU: Dr Alistair McInnes, PhD (Cape Town)

Doctoral
Cambridge – Gabriel Jamie
Lund – Ann-Kathrin Ziegler
Montpellier – André Ferreira, Aloïs Robert
NMMU – Katharina Reusch, Rabi'a Ryjklief, Gwendoline Traisnel
Oulu – Jere Tolvanen
Palacky – Michal Kysučan
Porto – Rita Fortuna
Pretoria – Matthew Noakes, Celiwe Ngcamphalala, Ryan O'Connor; Darren Pietersen, Michelle Thompson
Rhodes – Krista Oswald
UCT – Gordon Botha (SEEC), Edmund Rodseth (MCB)
Western Australia – Elizabeth Wiley

MSc by dissertation
CIBIO, Porto - Inês Duarte, Sandra Esteves
NMU – Jonathan Botha,Ilana Engelbrecht, Tayla Ginsberg, Jerry Molepo, Nick Pattinson, Danielle van de Heever
Lund – Johan Jensen
Oulu – Mira Sassi
Pretoria – Shannon Conradie, Ryno Kemp, MphoMalematja

BTech
TUT – Bonginkosi Ngomane

BSc Honours
Pretoria – Ryno Kemp, Mpho Malematja

Coevolutionary arms races in brood parasites and their hosts

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

Robert Thomson's team's work in Finland focusses on how host pairs of Common Redstarts *Phoenicurus phoenicurus* can completely avoid a Common Cuckoo *Cuculus canorus* laying an egg in their nest. Hosts that are able to avoid parasites would decrease the fitness costs of parasitism; the earlier that avoidance occurs during the breeding cycle would further minimize these costs. Therefore, adaptations occurring prior to egg laying would be especially beneficial for hosts. The Finnish project investigates frontline defences used by hosts and counter-adaptations by parasites, especially during nest site and territory location decisions which have received almost no attention to date. Redstarts are the only regular cuckoo hosts that breed in cavities; this aspect challenges adult cuckoos during egg laying and also challenges cuckoo chicks during the phase of evicting host eggs/chicks.

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

In collaboration with Claire Spottiswoode, Jessie Walton has been studying a population of Brown-backed Honeybirds *Prodotiscus regulus* which parasitise Karoo Prinias *Prinia maculosa* at a high rate in the Bot River area of the Western Cape. Among the Brown-backed Honeybirds' remarkable adaptations that we are investigating are 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. Rob Martin, who founded the honeybird project with Jessie Walton, passed away in May 2017; he is much missed.

Activities in 2017

- The summer in Finland was one of the coldest in recorded history. Despite lower numbers of breeding birds, an expanded field team monitored the nest boxes and performed

several experiments. Highlights included a new collaboration with Dr Rose Thorogood's team working on egg rejection in the Pied Flycatcher *Ficedula hypoleuca* and Mira Sassi's experiment on Redstart behavioural responses to Cuckoos.

- Two productive field seasons were carried out in Zambia by Gabriel Jamie working on indigobirds and whydahs, and Luke McClean working on honeyguides, both working closely with our team of nest-finders from the Semhawa Farm community.
- Jessie Walton, assisted by two recent graduates from U. Cambridge, Tanmay Dixit and Jana Riederer, carried out four months of fieldwork on Brown-backed Honeybirds at Bot River.

Highlights:

- Paper published in *Auk* about how informed habitat selection as an adaptation against brood parasitism may have implications for brood parasite-host coevolutionary interactions (Tolvanen, Forsman and Thomson 2017).
- Robert Thomson presented at the European Ornithologists Congress in Finland showing for the first time on video how cuckoos lay eggs in cavity breeding host nests.
- A paper was published in *Proceedings of the Royal Society B* on how multiple host species affect each other's ever-evolving eggs, with data from the remarkable collection of the late Major John Colebrook-Robjent in Zambia (Caves, Stevens and Spottiswoode 2017). This stimulated an article in *The Economist*, highlighting the research value of old egg collections.
- Gabriel Jamie received his PhD ('Mimicry and speciation in the parasitic finches of Africa') from U. Cambridge. He will remain in Claire Spottiswoode's research group as a postdoctoral researcher on the evolutionary genetics of egg colour.
- Olimpia Onelli passed her PhD thesis examination in the Department of Chemistry at U. Cambridge, supervised by collaborator Dr Silvia Vignolini. Her thesis included a chapter on structural effects of eggshell colour in Brown-backed Honeybird eggs from Jessie Walton's project at Bot River, and is currently being prepared for publication.
- Perspectives piece for the journal *Science* was published on a study by Mary Caswell Stoddard and others, providing a general theory for the evolution and development of egg shape in birds (Spottiswoode, 2017).

Tanmay Dixit and Jana Riederer from the University of Cambridge assisting Jessie Walton in the field near Bot River, Western Cape (Photo: Claire Spottiswoode).

Key co-sponsors

DST-NRF CoE grant; Academy of Finland; Finnish Cultural Foundation, University of Oulu graduate School; Biotechnology and Biological Sciences Research Council (BBSRC); The Leverhulme Trust.

Research team

Prof. Claire Spottiswoode (FIAO, UCT and U. Cambridge)
Dr Robert Thomson (FIAO, UCT)
Dr Nicholas Horrocks (U. Cambridge)
Dr Jukka Forsman (U. Oulu, Finland)
Prof. Tomáš Grim (Palacky University, Czech Republic)
Dr Chiara Mrosinoto (U. Padova, Italy)
Prof. Michael Sorenson (U. Boston)
Dr Rose Thorogood (U. Helsinki, Finland)
Jessie Walton (FIAO, UCT)

Students: Gabriel Jamie (PhD, U. Cambridge), Michal Kysučan (PhD, Palacky); Jere Tolvanen (PhD, Oulu); Luke McClean (MSc, UCT); Mira Sassi (MSc, Oulu).

Research assistants:

Finland: Claire Buchan, Felicias Pamatat, Shu Shan.
Zambia: Silky Hamama, Lazaro Hamusikili, Oliver Kashembe, Kiverness Moono, Collins Moya, Gift Muchimba, Sylvester Munkonka, Oliver Munsaka, Sanigo Mwanza, Calisto Shankwasiya and many others.
South Africa: Tanmay Dixit, Jana Riederer.

The evolution, ecology and conservation of honeyguide-human mutualism

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

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

Supported by a Consolidator Grant from the European Research Council, we are now asking 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, we hope, how quickly such cultures can be re-ignited following their loss. In so doing we hope to test for the first time the hypothesis that reciprocal learning can give rise to matching cultural traits between interacting species. Understanding the role of such phenotypic plasticity is crucial to explain how and why the outcome of species interactions varies in space and time, and to predict how they will respond to a rapidly changing world.

Our main objectives in 2017 were twofold. First, we carried out further experimental work to test the hypothesis that honeyguides learn the signals of their local human cultures, in collaboration with Dr Brian Wood from the University of California Los Angeles and the Max Planck Institute of Evolutionary Anthropology. We did so by working both with Yao honey-hunters at Niassa with whom we've collaborated for several years, and with Hadza hunter-gatherers of Tanzania who are also expert honey-hunters and also use a specialized (but different) sound to signal to honeyguides that they wish to cooperate. We received a grant from the National Geographical Society to expand this work further.

Second, we developed a customized app to allow honey-hunters in Mozambique to collect data on their activities, and trained 18 honey-hunters from Mbamba Village to use it. The app runs on rugged handheld Android devices, and

Honey-hunter Orlando Yassene holding a honey harvest (left), the outcome of cooperation with a Greater Honeyguide *Indicator indicator* (right) (Photos: Claire Spottiswoode)

enables users with any degree of literacy to collect accurate data on their interactions with honeyguides. This has been working very well, thanks to the enthusiastic support of the honey-gatherers and traditional chiefs of Mbamba Village, the Mariri Environmental Centre, and our data manager, Orlando Ncuela. The app was developed thanks to the expertise of software developers HabitatInfo. David Lloyd-Jones, who will begin PhD studies at the Fitz in 2018, was pivotal in training our initial cohort of honey-hunter collaborators to use the app. Their data will allow us to address a wide range of research questions concerning the ecology, evolution and ecosystem effects of this fascinating human-animal interaction. We are especially happy that this project is allowing us to directly involve Niassa's community in our data collection, providing them with additional sources of income as well as allowing us to cooperate in scientific research.

Activities in 2017

- In July, Claire Spottiswoode and Brian Wood carried out fieldwork on the honeyguide-human relationship with the Hadza people of northern Tanzania.
- From May to October, David Lloyd-Jones and Claire trained 18 honey-hunters to collect data on their activities with a custom app.
- During September and October, James St Clair, David and Claire captured and colour-marked honeyguides in two core study sites within our Mozambican study area, to establish a marked population for future experimental work.

Highlights:

- With the support of the Mariri Environmental Centre; the 18 honey-hunters are now successfully using the custom app to collect high-quality data on an ongoing basis.

Impact of the project

We hope this study will further our understanding of how mutualisms evolve, and specifically how learnt traits mediating mutualisms may coevolve with one another. Understanding mutualisms is broadly relevant because they help to shed light on the mechanisms that can maintain cooperation among unrelated individuals, and because they have wide reach in ecological communities. The honeyguide-human mutualism has already died out from large parts of Africa, as the continent develops; it would be a tragedy if it vanished altogether before we fully understood this part of our own evolutionary history.

Key co-sponsors

European Research Council; National Geographic Society; Max Planck Institute for Evolutionary Anthropology.

Research team

Prof. Claire Spottiswoode (FIAO, UCT and, U. Cambridge)
Dr Colleen Begg (Niassa Carnivore Project)
Keith Begg (Niassa Carnivore Project)
David Lloyd-Jones (FIAO, UCT)
Orlando Ncuela (Niassa Carnivore Project)
Dr James St Clair (U. Cambridge)
Dr Brian Wood (U. California Los Angeles and Max Planck Institute)

Cooperation and population dynamics in the Sociable Weaver

The evolution of cooperation is a central problem in evolutionary biology because individuals cooperate to help others at a cost to themselves, violating a basic principle of natural selection. Kin-selection theory provides an explanation for cooperation among kin, but cooperative interactions among unrelated individuals are commonplace. This poses a major challenge, which is to demonstrate how non-kin selected mechanisms may drive the evolution of cooperation.

This project investigates the benefits, costs and consequences of cooperation using the Sociable Weaver *Philetairus socius* as a study model. Akin to traditional human societies, these weavers have an elaborate social structure with different levels of organisation – the family, the neighbourhood that surrounds the family nest, and the colony – and they also collaborate on multiple tasks. These features allow a comprehensive study of cooperation in the wild. Additionally, the project's long-term demographic data now spans over 20 years, providing the possibility to investigate how sociality interacts with environmental factors to determine population dynamics.

Field assistant Ryan Olinger removes a Sociable Weaver from the net during the annual captures that take place between late August and early September (Photo: Franck Théron).

The current main focus of the Sociable Weaver project is to investigate the possible direct benefits arising from cooperation and, especially, whether there are benefits obtained through social or sexual selection. Cooperation may be under social or sexual selection if the individuals that are more cooperative are preferred by others as social or sexual partners. This hypothesis has received support in humans, but remains largely untested in other animals. Rita Covas, Claire Doutrelant and their team have been conducting work towards addressing these questions on the Sociable Weaver population at Benfontein near Kimberley. Post-doc Nora Carlson (CIBIO, Portugal), PhD student André Ferreira (University of Montpellier) and MSc students Sandra Esteves and Inês Duarte (CIBIO, University of Porto) are all conducting projects related to these questions.

Another main topic in this research programme is how sociality interacts with environmental conditions to determine individual life-history strategies and population trends. Rita Fortuna (CIBIO, University of Porto) was awarded a PhD bursary from FCT, Portugal to investigate how social and environmental factors influence female reproductive strategies and the consequences for offspring and colony dynamics.

Activities in 2017

- The 2017 bumper breeding season lasted nine months, during which 150 pairs in 13 colonies attempted to breed, producing a whopping 3 419 eggs. Of these, only 527 resulted in fledged young, essentially because of massive predation by snakes.
- Monitoring the adults at the nest produced over 2 000 videos that are still being analysed by project technician Liliana Silva (CIBIO). The data will be key to analysing

breeder and helper strategies. However, to improve data collection efficiency we started developing an alternative way to automatically collect nest attendance behaviour using PIT-tags and RFID readers.

- A collaboration between project technician Franck Théron (CNRS) and Jérémy Tornos (CNRS) produced a programme to enter breeding data directly in the field using a tablet. This was a major advance as it drastically reduced the time associated with data-entry and fieldwork planning.
- During the annual captures, a record number of 694 adults was caught by a team of 13 people.
- André Ferreira (PhD, U. Montpellier) and Sandra Esteves (MSc, CIBIO) conducted personality tests on 322 individuals to examine whether there is consistent variation in behavioural traits in this species and how that interacts with cooperative behaviour.
- Inês Duarte (MSc, CIBIO) collected data on dominance hierarchies at five colonies for her project on the relationship between social status and cooperative investment.
- Nora Carlson (Postdoc, CIBIO) successfully conducted a first season of field experiments to investigate the effect of a female audience on cooperative behaviour.
- André Ferreira, in collaboration with Damien Farine (Max Planck Institute, Germany), developed an automated system to collect associations between birds based on PIT-tags and RFID readers. This will allow the collection of large-volume data to study social networks in this species.
- Rita Fortuna (PhD, CIBIO) started fieldwork on the effect of helpers and environmental conditions on maternal effects.
- Franck Théron finished compiling the project's data into an integrated database. The breeding data now spans 10 years and contains over 18 000 records.

Highlights

- An article about the Sociable Weaver Project was published in *National Geographic* (Portuguese edition).
- A new post-doc, a new PhD student and two new MSc students joined the project.
- A paper was published in *Royal Society Open Science*, revealing that temperature plays a crucial role in determining the onset of breeding and breeding duration in Sociable Weavers; and a paper in *African Journal of Ecology* described the collective foraging behaviour of Sociable Weavers.
- A new automated data collection system using PIT-tags and RFID readers is now in use at five colonies and a new electronic note book allows efficient data capture directly in the field.

A new system to collect social associations uses RFID readers to read the PIT-tag numbers when the birds come to the feeders (Photo André Ferreira).

Impact of the project

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

Key co-sponsors

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

Research team

Dr Rita Covas (FIAO, UCT and CIBIO, U. Porto)
Dr Claire Doutrelant (FIAO, UCT and CNRS, France)
Dr Nora Carlson (CIBIO, U. Porto)
Dr Sophie Lardy (FIAO, UCT and CNRS)
Dr Arnaud Tognetti (U. Montpellier
Dr Fanny Rybak (U. Paris-Sud, France)
Franck Théron (CNRS, Montpellier)
Liliana Silva (CIBIO, U. Porto)

Students: André Ferreira (PhD, U. Montpellier); Rita Fortuna (PhD, U. Porto), Inês Duarte (MSc, CIBIO), Sandra Esteves (MSc, CIBIO)

Research Assistants: Marion Devogel, Antoine Grissot, Rita Leal, Ryan Olinger, Thomas Pagnon, Hugo Pereira, Franck Théron, Tanja van de Ven.

Pied Babblers and Fork-tailed Drongos

Tim Clutton-Brock originally established the Kuruman River Reserve to study group living in meerkats, but it has become the focus of several other long-running animal studies. Amanda Ridley's Pied Babbler Research Project was initiated in 2003 and uses habituated, free-living groups of Southern Pied Babblers *Turdoides bicolor* to understand the causes and consequences of cooperative breeding behaviour. In 2006 Amanda expanded the study to include the local Fork-tailed Drongo *Dicrurus adsimilis* population, investigating interactions between drongos, babblers and other species. Tom Flower joined the Drongo Project in 2008 to continue research on species interactions, with a focus on the drongos' use of false alarm calls to steal food from other animals. Recently, both Amanda and Tom have collaborated with Susie Cunningham to explore how increasing temperatures resulting from climate change will affect the reproduction and survival of babblers and drongos respectively in marginal desert environments.

The causes of conflict and cooperation in group-living societies

The Pied Babbler Research Project investigates the benefits of cooperation and the causes of conflict in this highly cooperative, group-living species. The study population of 12-19 groups has been monitored continuously for 15 years. Group size and number varies considerably according to weather conditions in the Kalahari, with the population suffering a considerable decline following breeding seasons with poor rainfall and high temperatures. The population also declines during very cold winters, when juveniles experience high mortality. Long-term life history data, along with short-term observations and experiments, have helped the team understand the causes and consequences of cooperative breeding behaviour. These findings help to reveal the benefits of cooperation not just in babblers, but from a broader evolutionary perspective.

How interactions between species shape animal behaviour

The Fork-tailed Drongo project explores how interactions with other species in an animal's environment can shape the evolution of behaviour. The project focuses on a population of over 40 pairs of habituated and colour-banded drongos that are individually recognisable. Research has primarily focussed on the drongo's deceptive use of false alarm calls, including mimicked alarms, to scare other species and steal their food. We are exploring how drongos learn both their repertoire of mimetic alarm calls and the deceptive tactics they use to steal food. In addition, together with Susie Cunningham, we are investigating the potential impact of climate change on bird persistence in hot desert environments. We consider whether increasing temperatures place thermoregulatory constraints on drongo foraging and offspring provisioning, thereby reducing survival and reproductive success. We are also investigating how drongos adjust their

Fork-tailed drongo *Dicrurus adsimilus* panting to offload excess heat. CB MSc student Ryan Olinger showed that these aerial acrobats reduce the number of foraging flights they make when air temperatures climb above 35^{0}C, resulting in less prey being delivered to hungry nestlings when the going gets hot (Photo: Nick Pattinson).

behaviour to reduce the impact of high temperatures on reproductive success, including through offspring shading, foraging tactics and even shifting to crepuscular or nocturnal activity.

Activities in 2017

- PhD student Amanda Bourne successfully completed her second field season on Pied Babbler behaviour and physiology and has submitted her first manuscript from this research. Amanda's field season included several different experiments in addition to the collection of observational data. It was a very dry breeding season in the summer of 2017/8 and as a result, breeding success was very poor.
- Amanda Ridley's student, Elizabeth Wiley, obtained her PhD from the University of Western Australia in November 2017. Her research on Pied Babblers revealed an impact of increasing heat and drought events on population dynamics. Elizabeth has published a paper from this research in *Animal Behaviour,* with several more in review.
- Martha Nelson-Flower used the long-term Pied Babbler database to comprehensively test new models for the occurrence of cooperative breeding with empirical data. Her paper will appear in a 2018 issue of *Journal of Animal Ecology*.

Highlights:

- Several papers on Pied Babblers were published, including on meaningful call combinations (Engesser *et al.* 2017. *Animal Cognition*) and the ecology of cooperation (Nelson-Flower *et al*, 2018 *Journal of Animal Ecology*).
- Amanda Ridley and Martha Nelson-Flower were invited to contribute to a new book on cooperation and conflict published by Cambridge University Press.
- Pied Babbler and Fork-tailed Drongo research was presented at several national and international conferences.
- CB MSc student Ryan Olinger graduated in June 2017. His findings will shortly be submitted for publication in *Global Change Biology* and will provide the first behavioural evidence that increasing temperatures associated with anthropogenic climate change decrease bird foraging because of the thermoregulatory constraints, and not just a decline in food availability.
- Tom Flower was an invited speaker at the "Fear: Brain, Behaviour, Society" conference hosted by the Aarhus Institute of Advanced Studies Conference, Denmark. Tom's talk was titled 'Risky information: Animals use deceptive communication to manipulate FEAR responses'.
- Tom Flower's participation at this conference has resulted in him leading a group drafting a review manuscript on the evolution of fearmongering in animal communication, which takes an interdisciplinary approach from microbiology to human politics.

Our research shows that Southern Pied Babblers begin to suffer costs related to the heat when temperatures exceed 36°C. These two, photographed on a hot afternoon, are showing typical responses to the heat: panting and ptiloerecting (Photo: Nick Pattinson).

For more details on the collaborative work between the Pied Babbler and Fork-tailed Drongo Projects and the Hot Birds Project, see the Hot Birds Project section of this report.

Key co-sponsors
DST-NRF CoE grant; Australian Research Council.

Research team
Assoc. Prof. Amanda Ridley (FIAO, UCT and UWA)
Dr Thomas Flower (FIAO, UCT and Simon Fraser University)
Dr Matt Bell (U. Edinburgh)
Dr Martha Nelson-Flower (U. British Colombia)
Dr Susie Cunningham (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT and U. Cambridge)
Prof. Andrew McKechnie (U. Pretoria)
Dr Simon Townsend (U. Zurich)

Students: Elizabeth Wiley (PhD, UWA); Amanda Bourne (PhD, UCT); Ryan Olinger (CB MSc, UCT).

Research assistants: Rita Leal, Sello Matjee.

Sociable Weaver nests as a resource

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

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

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

PhD student Anthony Lowney checking for associated species at a weaver colony at Tswalu (Photo: Anthony Lowney).

Activities in 2017

- BTech student Bonginkosi Ngomane (Tshwane University of Technology) investigated the impact of Sociable Weaver nests on plant community and diversity structure below colony trees.
- PhD student Anthony Lowney experimentally tested the interspecific hierarchy of the avian community that uses weaver chambers for roosting. Initial findings show that the hierarchy stands as (most dominant first) Pygmy Falcon, Acacia Pied Barbet *Tricholaema leucomelas*, Sociable Weaver, Ashy Tit *Parus cinerascens* and Scaly-feathered Finch *Sporopipes squamifrons*.
- Using playback experiments and presenting snake stimuli, Anthony also tested whether the Pygmy Falcons provide protection benefits to Sociable Weavers. Results suggest that Pygmy Falcons may provide colony defence, but only while they are breeding.
- UCT Hons student Billi Krochuk investigated the function of the conspicuous white faecal mat at the entrance of the colony chambers used by the Pygmy Falcons. She tested whether this mat has any antimicrobial function, thermal buffering effect or social signalling purpose for the Sociable Weavers.
- The Pygmy Falcon population in the study area

A female Pygmy Falcon waiting to roost in a Sociable Weaver nest colony for the night (Photo: Anthony Lowney).

was monitored for the seventh season. Postdoctoral Fellow Diana Bolopo has used these data to study the breeding ecology of the Pygmy Falcons. They present an unusual breeding strategy in birds: cooperative breeding, in which more than two adults attend a nest to fledge the chicks.

Highlights:

- A note describing intraspecific killing by a Pygmy Falcon was published in the *Journal of Raptor Research*.
- A note on the use of Sociable Weaver colonies by Cheetahs was published in *Biodiversity Observations.*
- Diana Bolopo presented the results of the breeding ecology of the Pygmy Falcons in an oral communication at the European Ornithological Union conference, held in Turku, Finland.
- Honours student Billi Krochuk, PhD student Anthony Lowney, and Robert Thomson all presented at the 8th Diamond Route Research Conference in Johannesburg.

Impact of the project

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

Key co-sponsors

DST-NRF CoE grant; Tswalu Foundation; Academy of Finland; University of Cape Town launching grant.

Research team

Dr Robert Thomson (FIAO, UCT)
Dr Diana Bolopo (FIAO, UCT)
Assoc. Prof. Michael Cramer (UCT)
Dr Bryan Maritz (UWC)

Students: Anthony Lowney (PhD, UCT); Billi Krochuk (BSc Hons, UCT); Bonginkosi Prince Ngomane (BTech, TUT).

Understanding colour polymorphism in birds

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

Colour morphs are known to influence the performance and fitness of individuals through both direct effects of pigment production (e.g. camouflage or thermoregulation) and indirect effects (e.g. correlated 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 melaonleucus* which occurs as either a dark or a light morph. The morph distribution of this species across South Africa follows a cline which is associated with winter rainfall patterns and the intensity of solar radiation. Thus, within the Western Cape we have a far higher proportion of dark morphs than the rest of the country. Our research has shown that the foraging success of the two morphs differs depending on ambient light levels, with dark morphs foraging more successfully in duller light conditions than the light morph, possibly due to improved background crypsis. Thus, in theory the two morphs when breeding together in a 'mixed' pair might be able to complement each other by expanding the conditions (daylight hour, prey or habitat types) in which parents can successfully forage and provision their offspring. Indeed, pairs consisting of mixed-morph parents produce more young than parents consisting of the same morphs, and their offspring show higher survival rates. The idea that pairs consisting of the two different morphs may complement each other has been termed the complementarity hypothesis. However, this fails to explain the predominance of dark morphs, because the light morph gene is dominant.

Nest camera in Fernwood – the female (dark morph) provisions food to her offspring.

We have developed a simple method to describe the morph distribution of birds and other organisms using photographic images sourced from the web. This method has been developed as a Web Application called MORPHIC which is free to use and is currently being used in research exploring multiple questions across the globe.

Activities in 2017

- PhD student Carina Nebel presented her proposal in October 2017. Her thesis will explore the complementarity hypothesis in more detail focusing on the likely mechanisms involved.
- Edmund Rodseth, PhD candidate in Molecular and Cell Biology (MCB, UCT), co-supervised

with Dr Rob Ingle (MCB), continued to make good progress on his study to identify the genetic pathway for colour polymorphism in Black Sparrowhawks.

- In collaboration with Dr Christopher Briggs (Hamilton College, United States) and Dr Chevonne Reynolds (University of Witwatersrand) we are using MORPHIC to understand the spatial structuring of Swainson's Hawk *Buteo swainsoni* morphs across North America.
- Another collaboration with Dr Chiara Morosinotto (University of Turku), Prof. Jon Brommer and Dr Patrik Karell (University of Helsinki) is using MORPHIC to describe the spatial distribution of Tawny Owl *Strix aluco* morphs across Europe in relation to climate, habitat, anthropogenic impact and diet.
- Several members of the research group presented their research at conferences; the British Ecological Society Annual Meeting, Ghent, Belgium, the European Ornithologists' Union, Turku, Finland and the Bird of Prey Programme of the Endangered Wildlife Trust, Witsand, Northern Cape.

Highlights:

- Gareth Tate published a paper in *Scientific Reports* using information on GPS tracked male Black Sparrowhawks to explore whether the two morphs differ in the amount of time spent foraging in relation to habitat type and light levels.
- Gareth Tate's PhD thesis was awarded the Purcell Memorial Prize for best thesis in Biological Sciences at UCT in 2017.
- Former BSc Hons student, Gabriella Leighton's paper in *Methods in Ecology and Evolution* introducing MOPRHIC, the web app using Google Images to describe spatial patterns of phenotypic variation, was awarded the British Ecological Society's Robert May Prize for the best paper by an Early Career Researcher. Gabriella was invited to present the research and receive the award at the BES conference in Belgium.

Impact of the project

This project will add to our understanding and theory about the maintenance of genetic diversity in populations. It provided the first empirical evidence for the light level hypothesis for the maintenance of colour polymorphism in birds. Our demonstration that Google Images can provide robust unbiased information on the spatial distribution of visible phenotypes, and the development of the MORPHIC web app, has opened up a whole new approach for research in this field.

Two juvenile Black Sparrowhawks in their typical rufous plumage. In all *Accipiter* hawks, the female (above) is significantly larger than the male (below) (Photos: Ian Junor).

Key co-sponsors
DST-NRF CoE grant; Claude Leon Foundation.

Research team
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Dr Petra Sumasgutner (FIAO, UCT)
Dr Gareth Tate (EWT)
Dr Jacqui Bishop (Biological Sciences, UCT)
Dr Rob Ingle (MCB, UCT)

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

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

Research Assistants: Dr Shane McPherson, Beckie Garbett, Jessleena Suri

Bird pollination in the Cape Floristic Region

Why do flowers come in so many different colours, both within and between species? This deceptively simple question is surprisingly difficult to answer. The Cape Floristic Region's bird pollination systems provide an ideal opportunity to address it in the context of natural communities of co-flowering species. Postdoctoral Fellow Anina Coetzee is tackling this question in collaboration with Claire Spottiswoode and Colleen Seymour. She is testing whether flower colour variation within species arises from selection for convergence in flower colour with other species in the local community, to benefit from shared signalling to pollinators. Such ecological processes may now be threatened by habitat fragmentation in many parts of the Cape Floristic Region, and understanding these effects is the goal of PhD student Daniël Cloete's research.

The genus *Erica* is one of the most diverse in the fynbos biome, and its many bird-pollinated species are striking for the high levels of colour polymorphism in their flowers. Some *Erica* species have up to five different colour morphs both within and between species. These species are pollinated predominantly by just one bird species, the Orange-breasted Sunbird *Anthobaphes violacea*, so the prevalence of these polymorphisms is a mystery. This project is investigating the origin and maintenance of these flower colour polymorphisms: what role does plant community context and sunbird foraging behaviour play in generating the intra-specific colour diversity of this group of plants, and how might habitat transformation influence these ecological and evolutionary processes?

Flower colour polymorphisms may evolve for two opposing reasons. Firstly, if co-existing species experience competition for the attention of pollinators, then colour divergence may promote assortative foraging by pollinators. Secondly, when a plant species receives low pollinator visitation rates, it may benefit from mimicking the signals of co-existing species in order to attract more pollinators. Evidence of such honest signal mimicry, as opposed to deceptive mimicry, is very rare in nature. A cause for concern is that habitat fragmentation may change sunbird behaviour in such a way that the evolutionary process maintaining this diversity in ericas is changed completely.

Fitz PhD student, Daniël Cloete, is working in and around the Tsitsikamma section of the Garden Route National Park to address the effect of habitat fragmentation on the fitness of bird-pollinated plants. Daniël's research aims to investigate how bird pollination relationships are affected by habitat fragmentation, and to test whether certain thresholds of patch size and isolation exist where pollination services by birds start to break down. To do so, he is measuring pollination by sunbirds and sugarbirds of *Protea* and *Erica* species across 17 fynbos patches, natural and fragmented, in areas located in the vicinity of Nature's Valley. This is a good area to address this question because it naturally comprises a matrix of forest, fynbos and coastal thicket, now further fragmented by agriculture, plantations, alien plant 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 are affecting, and will further affect, ecosystem function and services in the Cape Floristic Region.

The drone used to estimate the distribution and abundance of bird-pollinated *Proteas* (Photo: Daniël Cloete).

Daniël Cloete collecting nectar from *Erica densifolia* (Photo: Chrissie Cloete).

Activities in 2017

- Anina Coetzee completed surveys of ten communities of bird-pollinated *Erica* species in the south-western Cape, collecting data on sunbird visitation rates, pollinator-attracting traits and reproductive morphology. Three of these communities were sampled monthly to establish the flowering phenology patterns of co-existing species.
- Hybrid pollination experiments were conducted on three *Erica* species at two different sites.
- The study has found that flower colour diversity seems to be driven by two opposing processes: less attractive *Erica* species mimic the colour of favoured species to increase their visitation rate, but they also compete for pollen placement sites on sunbirds which causes colour divergence.
- Daniël Cloete completed a year of focused fieldwork, collecting data for each of the 17 fynbos patches. Bird abundance ws recorded in relation to bird-pollinated *Protea* flowering phenology and bird-pollinated *Protea* and *Erica* nectar traits and seed set.
- Aerial photos taken by a drone were used to estimate the distribution and density of bird-pollinated *Proteas* on each of the 17 sites.

Highlights:

- Anina presented the results of her study at the annual Evolution Meeting in Oregon, USA, and at the conference of the South African Association of Botanists in Pretoria.
- Anina was awarded a highly competitive Postdoctoral Fellowship from the Claude Leon Foundation. She also helped to train an intern from the rural Eastern Cape as part of her fieldwork.

Impact of the project:

The unique sunbird-*Erica* mutualism will allow us to gain key insights into the mechanisms by which individual 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 on pollination systems such as this will inform the development of guidelines for maintaining biodiversity and ecosystem functioning.

Key co-sponsors
DST-NRF CoE grant; The Botanical Education Trust; Biotechnology and Biological Sciences Research Council; South African National Botanical Institute; Harry Crossley Green Matter Scholarship.

Research team
Dr Anina Coetzee (FIAO, UCT)
Prof. Claire Spottiswoode (FIAO, UCT and U. Cambridge)
Dr Phoebe Barnard (FIAO, UCT and SANBI)
Dr Mark Brown (Nature's Valley Trust)
Prof. Peter Ryan (FIAO, UCT)
Dr Colleen Seymour (SANBI)

Student: Daniël Cloete (PhD, UCT)

Intra-African bird migration

Migrant birds are at greater risk of extinction globally than are resident species. To date, the emphasis has been on long-distance, inter-continental migrants. We are employing a broad-scale spatial approach to addressing questions of phylogeography, movement ecology, phenotypic variation and potential speciation in focal intra-African migrant birds that have seasonal breeding ranges across western, eastern and southern Africa. Since mid-2015, we have visited study sites in Nigeria and Ghana for western, Uganda for eastern and South Africa for southern Africa.

Little is known about the migratory routes, timing, drivers, connectivity and environmental prescriptions of intra-continental migrant birds in Africa compared to inter-continental migrants. This project investigates migratory patterns of focal intra-African migrant birds, including Woodland Kingfisher *Halcyon senegalensis*, African Pygmy Kingfisher *Ispidina picta*, Diederik Cuckoo *Chrysococcyx caprius* and Klaas's Cuckoo *C. klaas*.

An array of methods is being used to better understand these migrants. We are analysing single nucleotide polymorphisms (SNPs) and mitochondrial DNA sequences to explore genetic differentiation across each species' range. We are using ringing data, stable isotope analysis of flight feathers and telemetry data from geolocators deployed on suitable species to investigate their movement patterns. Phenotypic variation in vocalisations is being explored across the range and between genetically distinct populations. Linking these datasets to environmental data with statistical models should help to identify environmental drivers of migration, direct conservation action and possibly indicate anthropogenic-drivers of speciation.

A Woodland Kingfisher captured in a mistnet for analysis of moult patterns and stable isotopes in the flight feathers (Photo: Dayo Osinubi).

Activities in 2017

- The second southern African field season was completed (Nov 2016 – Jan 2017). The same three study areas from the 2016 season were visited in the Limpopo Province. Samples were collected from 15 Woodland Kingfishers, five African Pygmy Kingfishers, 16 Diederik Cuckoos and three Red-chested Cuckoos *Cuculus solitarius*.
- The second western African field season was completed (May-Jun 2017). Fieldwork was again conducted at the A.P. Leventis Ornithological Research Institute (APLORI) in Nigeria and at several sites around Accra and Damongo in Ghana. Samples collected include five African Pygmy Kingfishers, four Diederik Cuckoos, one Klaas's Cuckoo and one African Cuckoo *Cuculus gularis*. We are still trying to identify breeding sites of the nominate Woodland Kingfisher subspecies.
- The second eastern African field season was completed (July 2017). Several study sites around Entebbe and Jinja were visited in Uganda, where samples were collected from three Woodland Kingfishers, four African Pygmy Kingfishers and three Diederik Cuckoos. A reconnaissance visit was made to northern Uganda to explore areas of overlap between *Halcyon senegalensis senegalensis* and *H. s. cyanoleuca*. This search will be expanded in 2018.

- Eight multi-sensor geolocators donated by Vogelwarte (Swiss Ornithological Institute) for use on breeding Woodland Kingfishers were deployed during the second southern African field season. Two of these eight geolocators deployed were retrieved.

Highlights:

- Postdoctoral fellow Dayo Osinubi presented a talk at the 11th conference of the European Ornithologists' Union (EOU) in Turku, Finland (August 2017), which outlined the objectives and achievements of the intra-African bird migration project, and made a request for new collaborations.
- Dr Lisa Nupen, a research associate of the FIAO, and Dr Dieter Oschadleus, coordinator of the South African Bird Ringing Scheme (SAFRING) joined the expedition to Uganda for the second eastern African field season.
- Abigail Ramudzuli joined the South African fieldwork at the end of 2017. She will be joining the team as a MSc student at the FIAO in 2018, exploring moult patterns and location in the Woodland Kingfisher from moult scores and the analysis of stable isotopes.
- An African Bird Club (ABC) Expedition Award was granted to support the second eastern and the third southern African field seasons.
- A British Ecological Society (BES) Ecologist in Africa grant was awarded to support the third western and eastern, and fourth southern African field seasons.
- A Schifferli Scholarship was awarded to Dayo Osinubi by Vogelwarte for him to visit Switzerland in September 2018 to learn how to analyse multi-sensor geolocator data.
- Vogelwarte further supported the project with the donation of 15 more geolocators for use on Woodland Kingfishers breeding in southern Africa. During the third southern African field season eleven of the new geolocators were successfully deployed.

Impact of the project

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

Dayo Osinubi using his tree climbing skills to access a nest box used by the Woodland KIngfisher (Photo: Dayo Osinubi).

Key co-sponsors

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

Research team

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Prof. Desire Dalton (NZG)
Dr Phoebe Barnard (FIAO, UCT)
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Research Assistant: Abigail Ramudzuli.

Evolution in island birds and the 'insularity' syndrome

Islands are renowned natural laboratories for the study of ecology and evolution given their isolation, small area and simple biotas. However, many aspects of island ecology and evolution remain poorly understood. Our studies on island birds have shown that insularity favours reduced fecundity, extended developmental periods, increased sociality, and reduced sexual dimorphism in plumage (and a tendency for duller plumage in island birds). Our research is now focusing on the mechanisms underlying these patterns. Current research topics include host-parasite dynamics and immunity, evolutionary genomics as well as the role of inter-specific competition on song evolution.

The low species richness on islands results in increased population densities and niche enlargement among island birds, but it remains unclear if these characteristics extend to the parasite community. Martim Melo and Rita Covas have been working in the Gulf of Guinea islands and nearby mainland areas for over 15 years and, in collaboration with Claire Loiseau (CIBIO, University of Porto) analysed c. 2,000 blood samples for 'avian malaria' *Haemosporidia* parasites. The results confirmed lower parasite pressure on the islands. In addition, the island parasite assemblage was distinct, comprising a mix of generalist and specialist parasites that we interpret to represent, respectively, recent arrivals and ancient colonisation events (which have evolved into endemic lineages, as proposed by E.O. Wilson's taxon cycle hypothesis).

But these results may not hold for different types of parasites. Similar analyses conducted for *Trypanosoma* parasites did not reveal any striking dissimilarities between the island and mainland communities. Finer scale analyses are currently underway, but these results appear to indicate that *Trypanosoma* are generalist parasites with widespread distributions.

An important and unresolved question is whether reduced parasite pressure on islands is associated with reduced immune function. Our previous results showed that different immune parameters responded differently to the island environment, prompting further study. A new application for funding in collaboration with Benoit Nabholz (University of Montpellier, France) has been made in order to conduct a new approach to investigate the effects of insularity on the evolution of toll-like receptors (TLRs), a class of proteins that play a key role in the innate immune system.

Martim Melo rings a São Tomé Grosbeak – only four individuals were captured in a 15 year period, proving the precious samples required to unravel the origins of this enigmatic species (Photo: Alexandre Vaz).

Work on avian diversification at the Gulf of Guinea islands conducted by Melo in collaboration with Martin Stervander and Bengt Hansson (University of Lund, Sweden) has shed light on the evolutionary history of one of the few candidate cases for sympatric speciation in birds: the enigmatic São Tomé Grosbeak *Crithagra concolor* and its sister species, the Príncipe Seedeater *C. rufobrunnea*. Using a genome-wide approach, they showed that the

two ancestral populations on São Tomé hybridized, leading to extensive introgression. The genomes of both species are now a complex mosaic made of each other's genes. Of interest is the fact that the genomic segments that remain unique to each species are close to regions containing genes determining bill morphology. This strongly suggests disruptive selection between the two species during divergence in sympatry.

Another project is investigating the role of reduced interspecific competition in the evolution of bird song on islands. PhD student Alois Robert (University of Montpellier, France) conducted field work together with Martim Melo, Claire Doutrelant and Thierry Lengagne (University of Lyon, France) in tropical and temperate island locations (São Tomé, Cameroun, Madeira and southern France) to record the acoustic space of islands and mainland populations using SM3 boxes. Initial results indicate that there is less competition for acoustic space on tropical island populations compared to mainland ones, but no differences for the temperate communities.

Activities in 2017

- A comprehensive study of the evolutionary genomics of one of the few candidate cases for sympatric speciation among island birds was concluded.
- Analyses on the distribution of *Trypanosoma* indicated that, unlike avian malaria, these parasites do not appear to be influenced by insularity.
- A grant application was submitted to investigate the effects of insularity on the immune system using toll-like receptors.
- Claire Doutrelant, Alois Robert and Thierry Lengagne (CNRS, France) conducted fieldwork in Madeira and South of France to record individual songs and the dawn chorus of the bird communities.

Highlights:

- A paper was published showing that birds in the Gulf of Guinea islands generally enjoy reduced parasitism from avian malaria (Loiseau *et al.* 2017. *J. Biogeography*).
- A paper was published uncovering the sister-species relationship between the São Tomé Grosbeak and the Príncipe Seedeater. We demonstrated that the grosbeak is a giant canary, by far the largest in the genus. This result was picked up by many media outlets, including *Scientific Americ*an and received an Altmetric score of 178 (i.e. top 5% of all research outputs scored by Altmetric).
- The first capture of a Príncipe Scops Owl, a species only discovered in 2016 after almost 20 years of surveys. Preliminary genetic analyses demonstrate that it is a new, highly distinct, species.
- PhD student Alois Robert presented his work at the International Bio-Acoustics Conference in India.

The endemic Principe Golden Weaver being measured as part of a study into morphological evolution on islands (Photo: Anne Delestrade).

Impact of the project

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

Key co-sponsors

FCT (Portugal); National Geographic; British Ecological Society; DST-NRF CoE; CNRS (PEPS); University of Montpellier (PhD grant to Aloïs Robert).

Research team

Dr Rita Covas (FIAO and CIBIO, U. Porto)
Dr Martim Melo (FIAO and CIBIO, U.Porto)
Dr Claire Doutrelant (CNRS and FIAO)
Dr Claire Loiseau (CIBIO, U. Porto)
Dr Martin Stervander (U. Lund, Sweden)
Dr Bengt Hansson (U. Lund, Sweden)
Dr Thierry Lengagne (CNRS, U. Lyon)

Student: Aloïs Robert (PhD, CNRS and U. Montpellier).

Smart beaks: non-visual senses in birds

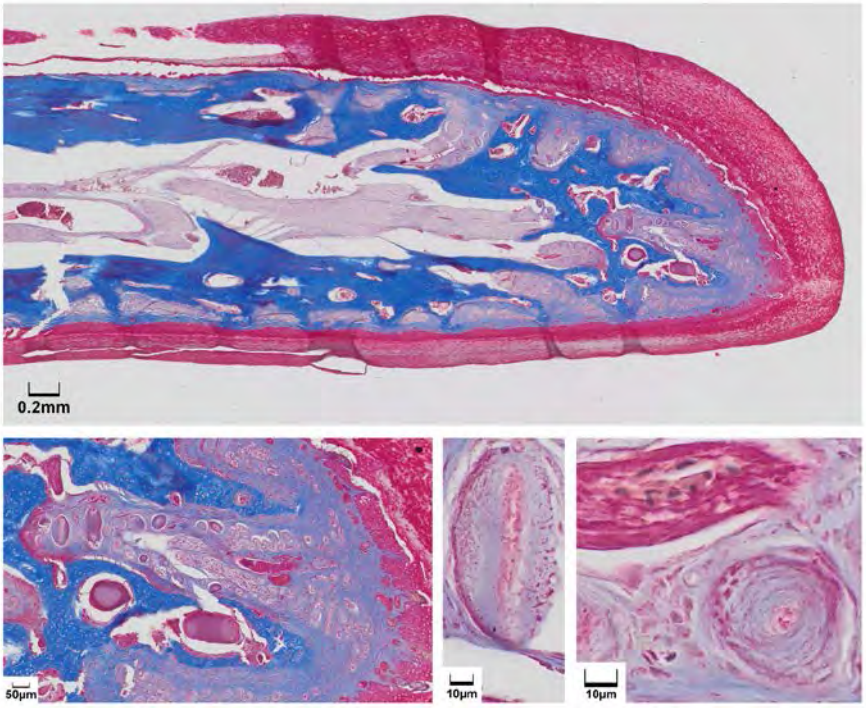
Most birds, like most people, have excellent vision. This is part of what makes birds such an appealing group to study. However birds navigate their world using different senses as well. In this project, we investigate the non-visual senses of birds with a focus on tactile senses in their beaks. The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

This project is led by MSc student Carla du Toit. In 2017, her research focused on the anatomy of the bill-tip organ in the three ibis species resident in South Africa. The bill-tip organ of probe-foraging birds is made up of mechanosensory receptors embedded in densely clustered pits in the bone at the tip of the bill. Although the general structure of the bill-tip organ is similar across all probe foraging species that possess it, there is interspecific variation in the shape and orientation of the pits and the receptors within them. The overall aim of Carla's thesis is to use ibises as a model to investigate the link between the morphology of the bill-tip organ and the birds' foraging ecology, and to explore whether these patterns can be extrapolated to infer information about the foraging ecology of extinct bird species.

Carla hypothesizes that there is a relationship between the morphology and histology of the bill-tip organ and the foraging ecology of ibises. Hadeda, Sacred and Glossy Ibises are ideal model species for investigating this hypothesis, because they forage in different substrate environments ranging from terrestrial to aquatic sites. Carla started the project as an MSc student at the beginning of 2017, and an upgrade to PhD was approved in November. During 2017, she sourced skeletal material of the three study species to measure and describe the sensory pits in the bony bill-tips of the birds. Carla sourced samples from South African museums and also travelled to the UK and France and visited multiple museum collections there. In addition, she was able to visit palaeontology collections to source fossil birds for the study. Carla completed µ-CT scans of two Hadeda and two Sacred Ibis specimens, using the CT scanning facility at Stellenbosch University, in conjunction with technician Dr Anton du Plessis. The data from these scans are now ready for analysis. In addition, she optimized the methods of preparation and staining of fresh tissue from bill-tips of accidentally-killed (road killed, euthanized at SANCCOB due to injury, etc.) ibises for histological study, and secured sufficient specimens of Hadeda and Sacred Ibises for this purpose. Together with Susie Cunningham, she performed a short pilot study to develop the methods to describe the specific foraging behaviours of these species in the wild.

Highlights:

- Carla's registration will be upgraded to PhD level from January 2018.
- Analyses of ibis skulls showed an increase in the length of the beak that is pitted as well as the number of sensory pits with increasing use of aquatic habitat, consistent with the pattern shown in other species of ibis from other parts of the world.
- The pattern of pitting between the three species differed, with Glossy Ibises having a higher number of pits on the inside surfaces of their beaks than the other two species. This could indicate that Glossy Ibises are probing with their beaks open more often than the other species, which will be confirmed by observing wild foraging birds..
- The histological sections already performed indicate clear differences between the three species in terms of the arrangement of the



Top: Longitudinal histological section through a Hadeda upper beak tip, stained with a trichrome stain. Images show bone (dark blue), soft tissue (lilac) and keratin (red) layers of the beak.. Bottom: (left) Long section through a single sensory pit, with a nerve bundle running the length of the pit and circular mechano-sensory receptors above and below this; (middle) a long section through a mechanosensory receptor (Herbst corpuscle) showing a central nerve fibre surrounded by a capsule of connective tissue; (right) a cross-section through a Herbst corpuscle.

A ventral view of a Hadeda beak tip with keratin and soft tissue layers removed, so that the sensory pits of the bill-tip organ are visible (photograph of a museum specimen). (Photo: Carla du Toit).

sensory receptors and soft tissues within the bony pits, with Sacred and Glossy Ibises bearing a close resemblance to each other, and Hadedas being significantly different.

- At the British Natural History Museum, Carla found several specimens of fossil scolopacid birds with their beaks very well preserved. She will be comparing these to modern specimens to look for differences in the structure of the bill-tip organ over time in this family.

Impact of the project

This work will help us better understand the links between anatomy, morphology and behaviour in birds. From a conservation and global change perspective, it will allow a better understanding of the substrate conditions under which ibises are best equipped to forage successfully, improving understanding of potential mechanisms underlying the expansion of Glossy Ibises and Hadedas into the south and west of South Africa, and the likely impact of the current drought and ongoing climate drying on the foraging success of these species. Planned comparative work on paleontological specimens will improve our understanding of the ecology of extinct birds.

Key co-sponsors
DST-NRF CoE grant.

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

Student: Carla du Toit (PhD, UCT)

Impacts of power infrastructure

Over the last few years the Fitz has been involved in projects to mitigate the impacts of power generation and transmission infrastructure. 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, which is run in close collaboration with BirdLife South Africa's Birds and Renewable Energy programme, received a considerable boost in 2016 with the awarding of a grant from the Hans Hoheisen Charitable Trust to fund a full-time research assistant for three years. Vonica Perold, a former field assistant on Marion Island, was appointed to this position from August 2016. A presentation to the ABAX Foundation in December 2016 also resulted in further funding to model the impacts of wind farms on Verreaux's Eagles *Aquila verreauxii.* Progress on this latter project is reported separately in the section "Conserving Verreaux's Eagles".

Activities in 2017

- Gathering of field data from the large-scale experiment to test the efficacy of transmission line marking (using flappers or static flight diverters) to reduce collision mortality finally came to an end 8 years after it was initiated as part of Jess Shaw's PhD on mitigating powerline collision risks for large birds in the Karoo. This study, set up in the De Aar region of the eastern Nama Karoo, was a partnership between ESKOM, the Endangered Wildlife Trust (EWT) and UCT. Jess, now based in Scotland, and former post-doc Tim Reid, now based in Australia, completed analyses of the collision data to show that marking lines reduces collisions of Blue Cranes *Anthropoides paradiseus*, but has no significant benefit for Ludwig's Bustards *Neotis ludwigii*. Jess is preparing a paper for publication on this very important experiment.
- CB MSc student Sydney Davies worked with Tanya Smith (EWT) to analyse the first 1-2 years of accurate GPS-GSM tracking data collected for Blue Cranes in the Overberg. The aim of this project is to better understand how cranes move in this region, which is home to the world's largest population of this species. Collisions with powerlines remains a key concern for cranes in this region. Sydney found considerable variation among individuals. Non-breeding birds tend to have larger home ranges than breeding birds, but this is not always the case. Some adults greatly reduced their home ranges while breeding, while others actually ranged further while breeding. We plan to expand this project into the Swartland, where former CB MSc student Julia van Velden found that there are more conflicts between cranes and farmers.

A meta-analysis of wind farm monitoring studies shows that a surprising diversity of birds collide with wind turbines in South Africa (Photo: Peter Ryan).

- Vonica Perold worked with Sam Ralston-Paton (BLSA) to review the first two years' of bird mortality monitoring at wind turbine facilities around South Africa. They are currently finalising a paper summarising the numbers of birds killed. Raptors remain the species of greatest conservation concern, with significant numbers of both Accipitriformes and Falconiformes killed, but perhaps more surprising is the indiscriminate nature of windfarm mortalities, affecting close to 100 species of birds so far at projects mainly located in the Eastern and Western Capes.
- Robin Colyn (BLSA) started working with the Fitz to better understand the factors determining the distributions of range-restricted larks in the Karoo regions of southern Africa. He will also assess display flight heights of Red Larks *Certhilauda burra*, a species of particular concern given the large number of wind energy projects planned in the range of this localised, vulnerable species.
- Industrial-scale solar power generation also is growing rapidly in South Africa, with little information on the impacts on biodiversity. Vonica assisted former CB MSc student Elke Visser submit a paper on the impacts on birds of South Africa's largest photo-voltaic plant. Fortunately, Elke found very few mortalities; even accounting for a fairly high scavenger removal rate of small birds, it is unlikely that significant numbers of any bird species are being killed by the facility.
- CB MSc student Corey Jeal completed his study of a concentrated solar power (CSP) 'trough' facility, Bokpoort, near Groblershoop in the Northern Cape. With Vonica's assistance, he has two manuscripts ready for submission, one reporting the impact of the facility on birds in the region, and the other on macro-invertebrates. Vonica is following up with the plant management to ensure that recommendations to reduce the risk of animals drowning in the plant's evaporation ponds have been implemented.
- We were unable to study the impacts of CSP towers directly, but the first year of monitoring at the only facility in South Africa revealed worryingly large numbers of birds impacted by mirror collisions (mainly passerines) and solar flux damage (swifts, swallows and a few raptors).

CB MSc student Corey Jeal found that the CSP plant at Bokpoort created abundant habitat for Barn Owls (Photo: Peter Ryan).

Highlights:

- Jess Shaw's paper on the impacts of powerline collisions on bustards in the Karoo was published online in *Ibis*.
- Additional GSM-GPS trackers were deployed on Blue Cranes in the Overberg region to track their long-term movements in collaboration with the EWT and CapeNature, with initial analyses of the data being undertaken by CB MSc student Sydney Davies.
- Vonica Perold and Samantha Ralston-Paton have summarised all reports of bird and bat mortalities for commercial windfarms undertaking post-construction monitoring in South Africa.
- Corey Jeal obtained his MSc on the impacts of a 'trough' concentrated solar power plant in the Northern Cape, and has two papers in preparation reporting his findings.

Key co-sponsors
Endangered Wildlife Trust-Eskom Strategic Partnership; Hans Hoheisen Charitable Trust.

Research team
Prof. Peter Ryan (FIAO, UCT)
Dr Arjun Amar (FIAO, UCT)
Robin Colyn (BLSA)
Dr Andrew Jenkins (FIAO, UCT)
Dr Me gan Murgatroyd (FIAO, UCT)
Vonica Perold (FIAO, UCT)
Samantha Ralston-Paton (BLSA)
Dr Tim Reid (ANU, Canberra)
Dr Jess Shaw (Scottish Natural Heritage)
Dr Rob Simmons (FIAO, UCT)
Tanya Smith (EWT)

Students: Sydney Davies (CB MSc, UCT); Corey Jeal (CB MSc, UCT).

Conserving Martial Eagles

The Martial Eagle 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 that have been observed within the largest protected area in the country, the Kruger National Park (KNP). This research is important to understand the role that protected areas have in species conservation and to understand specific threats and habitat requirements for the conservation of Martial Eagles.

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

We aim to improve our understanding of the threats faced by this species and how these threats may drive population declines even within protected areas, where species are usually expected to be conserved. Our original hypothesis for these declines was that Martial Eagles may be subject to increased mortality outside of protected areas, particularly during immature life stages when inexperienced eagles are likely to range into areas with increased human pressures.

Contrary to this hypothesis, data collected since 2013 did not find evidence for low survival during these early life stages despite ranging widely beyond protected area boundaries. However, through GPS tracking of adult birds and nest monitoring, two potential factors that may be contributing to the observed population declines have been detected: low adult survival and poor breeding productivity. Adult mortalities, including persecution and electrocution, during unexpected wide-ranging movements outside of the KNP, may be contributing to declines. The poor breeding productivity comes in two forms: both a lower than average number of pairs making a breeding attempt and low success of those pairs which do try. To better understand the latter, our primary aim going forward is to install cameras at a number of nests. We will also continue to investigate the eagles' movements in the KNP using GPS tracking. In 2018, in a partnership with the Endangered Wildlife Trust (EWT), we will investigate the breeding and movement ecology of the substantial population of Martial Eagles that nest on electricity pylons in the Karoo. This will help us to understand national population declines and the requirements of the species.

Activities in 2017

- Megan Murgatroyd monitored the breeding activity of 33 pairs of Martial Eagles in the

Nest camera photos showing (left) a large chick (>8 weeks old) photographed in the mid season survey, and right, the feather remains of this chick on the nest in November this year.

Wide ranging immature Martial Eagles are less prone to threats than was previously thought (Photo: Megan Murgatroyd).

KNP, via three nest surveys (early, mid, late season).

- The 2017 early season surveys showed a promising breeding attempt rate with 15 attempts (close to 50% of the population, expected for a biannual breeder). However, mid-season surveys showed poor success with high failure rates and the late season monitoring revealed another two nest failures. One of which was the loss of a large chick that would have been close to fledging. Feather remains were found on and below the nest. Nearly half of the 2017 breeding attempts failed for unknown reasons.
- We continued to track several adult and juvenile eagles. An additional adult eagle was tagged in the KNP and its nest was located via the GPS tracking data.
- SANParks authorised a research addendum allowing the collection of prey remains below nests. We have started to collect remains for a diet analysis, which might give an insight into why some territories do better than others.

Highlights:

- Rowen van Eeden graduated with his PhD in June 2017.
- Rowen's paper on adult habitat preferences and ranging behaviours was published in *PLoS ONE* (van Eeden et al. 2007. *PLoS ONE* 12(3): e0173956).
- We also published key research that quantified the overall decline of the species across South Africa and within the KNP (Amar & Cloete in press, *Bird Conservation International*). This paper was widely reported on in the South Africa media.

Impact of the project

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

Key co-sponsors
ABAX Foundation; DST-NRF CoE grant; Endangered Wildlife Trust.

Research team

Dr Arjun Amar (FIAO, UCT)
Dr Megan Murgatroyd (FIAO, UCT)
Dr Gareth Tate (FIAO, UCT, Endangered Wildlife Trust)
Dr Rowen van Eeden (FIAO, UCT)

Conserving Verreaux's Eagles

Verreaux's Eagle *Aquila verreauxii* has recently been uplisted to Vulnerable in South Africa due to decreases in range and abundance recorded by the Southern African Bird Atlas Project. Land use change, habitat loss and more recently, the development of the wind energy industry, all pose threats to this species. Initially, this project explored the ecology of Verreaux's Eagles in natural and agriculturally transformed habitats. Generally regarded as a highly specialised raptor, habitat transformation was predicted to reduce availability of its preferred prey species, the Rock Hyrax *Procavia capensis*, resulting in reduced breeding productivity or increased foraging efforts. Contrary to this prediction, our research in the Cederberg and Sandveld regions of the Western Cape found that Verreaux's Eagles are in fact diversifying their diet in agriculturally developed areas and their breeding productivity does not appear to be negatively impacted at the levels of agricultural transformation currently encountered by eagles in the Sandveld region.

The demand for renewable power is increasing worldwide and electricity generation from wind power is growing rapidly. In South Africa, there are currently 19 operational wind energy developments, with more than 600 turbines, producing 1.47 GW. The Department of Energy has committed to producing 13.23 GW of renewable energy generation by 2025. Although wind energy may be a sustainable solution to our increasing energy demands, it is not without its environmental impacts. Large raptors, particularly vultures and eagles are susceptible to turbine collisions, and to date in South Africa six Verreaux's Eagle mortalities have been recorded. This project aims to build a predictive mapping tool for Verreaux's Eagles to enable the placement of turbines in areas that will minimise the risk of collision for these eagles.

A Verreaux's Eagle equipped with a high resolution solar GPS tag. (Photo: Miqkayla Stofberg).

To do this we are using high-resolution GPS tracking technology to understand flight behaviour, habitat use and the associated risk of wind turbine collisions. Using GPS data from Verreaux's Eagles we are building habitat use models that explore how territory holding eagles use the landscape. In particular, this will help us to understand how factors such as distance from the nest and topographical features influence their movements and the potential for wind turbine collisions. The aim is to incorporate these models within a user-friendly, web-based interface for use by the wind energy industry to obtain a collision risk map of any potential development areas early in the planning stage, thereby ensuring that wind turbines can be placed in locations that will minimise risk to flying eagles.

Megan Murgatroyd holding a Verreaux's Eagle before fitting a GPS tag (Photo: Miqkayla Stofberg).

Activities in 2017

- Five Verreaux's Eagles were fitted with high-resolution GPS tags. This brings our sample size of tagged eagles up to 16 individuals, which is deemed sufficient to build our predictive model.
- As habitat type, topography and eagle density might impact the likelihood of eagle collisions with wind turbines, we expanded our tagging activities into new areas. Understanding these impacts will be important for the national application of the final model.
- We continued data downloads from five eagles in the Karoo. These are now our longest running tags (1.5 years +) and these individuals all made a breeding attempt this year, indicating that these tags are not detrimental to the welfare of the birds.

Highlights:

- The first pair of Verreaux's Eagles was tagged. Tracking data from both members of the same pair will allow us to assess if there is differential collision risk between the sexes and will give the first quantitative assessment of pair behaviour in this long-term monogamous species.
- The first version of the risk model built using a subset of data from six eagles, was applied on a local scale for a turbine development site in the Karoo. It indicated that the proposed development posed high risk to eight pairs of resident eagles.
- Presentations were given to the Endangered Wildlife Trust Birds of Prey programme, the Weskus Bewarings Kommitee, the Greater Cederberg Biodiversity Corridor Steering Committee, Tygerberg Bird Club, BLSA's Vulture Working Group and the West Coast Bird Club.

Impact of the project

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

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

Research team
Dr Arjun Amar (FIAO, UCT)
Dr Megan Murgatroyd (FIAO, UCT)

Vulture conservation

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

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

Working with Raptors Botswana, we are involved in a research programme to conserve Botswana's significant populations of vultures. All five species in the country are endangered or critically endangered. Central to this research is an attempt to quantify changes in vulture populations in Botswana over the last 20 years by repeating road transects undertaken in the early 1990s. Additionally, repeat aerial surveys have been conducted between 2005 and 2017 in Khwai and Linyanti, two of the most important breeding areas for African White-backed Vulture *Gyps africanus,* to assesschanges in nesting numbers and breeding success. Another focus of this research has been on lead (Pb) levels in vulture blood and how these vary inside and outside of hunting areas and hunting seasons. This research also has a special focus on understanding the movement patterns and the current rates of productivity of Lappet–faced Vultures *Torgos tracheliotos*. Beckie Garbett (PhD) and Leungo Leepile (MSc) are leading this work.

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

With key collaborators VulPro and EWT, we are investigating the role that vulture restaurants can play in vulture conservation in South Africa. We aim to collate data on the spatial and temporal availability of food at vulture restaurants, and to examine the benefits and costs that these may entail with regards to vulture breeding success, health, poisoning risk and behaviour. We are working with farmers, particularly from the pig industry, to gain insights into their role in providing carrion for vulture restaurants that can provide a win-win strategy for farmers and vultures.

In Namibia, we have investigated poison use as a threat to vultures and also work with Vultures Namibia on understanding movements of Lappet-faced Vultures breeding in the Namib-Naukluft National Park. We plan to repeat the Namibia study to map poison hotspots in South Africa and to understand the factors and conflicts that impact poison use in order to find solutions for the farmers, which will indirectly benefit vultures. Using these hotspots and tracking data we will attempt to quantify the level of poison risk aversion that vulture restaurants provide.

Activities in 2017

- PhD student Beckie Garbett completed the repeat raptor road transect surveys initially carried out during 1991-1995 in northern Botswana. Four of the five vulture species declined overall, with White-headed Vultures and Lappet-faced Vultures showing significant declines as large as >70%.
- Our research found elevated blood lead levels of White-backed Vultures were associated with both hunting areas and hunting season. These findings suggest that the main source of lead in vultures is likely to be from spent lead ammunition.

- Data from 14 GPS tagged adult Lappet-faced Vultures in Botswana has been analysed. During the tracking period 2012-2017 they moved within five countries in southern Africa, including Botswana.
- PhD student Christiaan Brink is updating and verifying a vulture restaurant database for South Africa. To date 100 vulture restaurant managers have been interviewed about their motivations for running restaurants, as well as their perceptions on vulture conservation issues.
- CB MSc student Tapiwa Zimunya completed a preliminary analysis exploring the benefits of vulture restaurants on breeding success and chick body condition for White-backed and Cape Vultures, *Gyps corprotheres*. This analysis will be updated with the improved vulture restaurant database.
- CB MSc student Leungo Leepile repeated aerial nest-surveys at the two colonies in northern Botswana. His data indicated large declines in nesting numbers and breeding success of White-backed Vultures. Modelling suggests that the region is acting as a population sink.

Highlights

- Together with collaborators at VulPro and University of Swaziland, Tapiwa published a paper in *Ostrich* which explored the possibility to sex Cape Vulture based on morphometrics.
- Christiaan Brink presented a poster at the International Ornithological Union Conference in Turku on his investigation of the feasibility of a potential Bearded Vulture reintroduction in South Africa. A related paper has been submitted to *Ecology and Evolution* and is currently in review.
- Christie Craig, Robert Thomson and Andrea Santangeli published a paper in *Ostrich* looking at how Namibian communal farmers view vultures and the cultural uses of vulture parts.
- Christie presented her CB MSc project on identifying poison use hotspots in Namibia at the EWT Birds of Prey conference.
- A paper on the lead levels in White-backed Vultures by Beckie Garbett and Arjun Amar was published in *Science of the Total Environment*.

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, poisons 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 better understand why, what, where and how vulture threats occur, with implications for targeting cost-effective conservation actions.

Critically Endangered White-backed Vultures feeding at a carcass in Botswana (Photo: Beckie Garbett).

Key co-sponsors

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

Research team

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Students: Beckie Garbett (PhD, UCT), Christiaan Brink (PhD, UCT); Christie Craig (CB MSc, UCT).

Black Harriers – Ecology and Fitness

The Black Harrier *Circus maurus* is among the rarest raptors in southern Africa. At an estimated 1 000 individuals it vies with Botha's Lark *Spizocorys fringillaris* as South Africa's least common endemic. With previous research indicating it shows no mtDNA genetic diversity, this 18-year research programme seeks to determine why the species is so rare and what conservation measures are required to safe-guard its future in the modern world..

This migrant and nomadic species spends the winter and spring in the Fynbos biome breeding after the winter rains. As the hot summer sun dries out its foraging grounds in the west, it wings its way across the arid Karoo to the green highveld grasslands of Lesotho, the Free State and the Eastern Cape. Satellite-tagging studies show this journey of 1 000 km is taken at speeds averaging 60 km/h and birds can be in the Drakensberg four days after leaving the Cape Fold mountains and Langebaan breeding areas. Unlike most other raptors, the Black Harrier shows low fidelity to its breeding grounds and may breed up to 500 km away from its previous years nest – a unique behaviour amongst Africa's raptors.

Significant progress has been made over the last four years in understanding the reasons for Black Harriers' scarcity, with the findings from Marie-Sophie Garcia-Heras' PhD research. She conducted fieldwork during the 2012-2015 breeding seasons in two geographical regions: one coastal in the Western Cape Province, and the second in the hills of Nieuwoudtville in the Northern Cape. Historical data collected by Rob Simmons covering 13 years prior to that allowed a large sample of 490 nests to form the basis of this research.

The main questions to be answered were: where is it most productive? (so those areas can be conserved); what health factors may be limiting it ?(such as chemical pollutants) and do climatic factors play a role in its rarity ?(climate change is predicted to increase temperatures and decrease rainfall in its core breeding areas of the Western Cape). Marie-Sophie's main findings are:

- The importance of coastal regions (especially the fynbos biome) was highlighted because productivity in this habitat was almost 3-fold higher than in inland areas. This is because breeding starts earlier, lasts longer, nesting occurs at higher density, and food supplies are consistently higher.
- Climatically cool weather conditions are more conducive to day-long hunting; birds breeding in the hotter interior provisioned fewer mice at midday in warmer temperatures than those at the coast in cooler conditions. This may have arisen from the reduced activity of the mice or the harriers themselves; this climate signature suggests that climate change in their breeding areas may have a negative impact on the birds in the long term.
- Neither provincial nor private reserves offered protection against persistent chemical pollutants such as DDT and PCBs – some of the highest levels of PCBs were found in the Koeberg Nature Reserve and other reserves to the north;
- Blood samples indicated that 79% and 84% of 114 nestlings and adults tested were contaminated with PCBs and DDT respectively. As banned chemicals in the Western Cape these results for DDT (in chicks) provide a conundrum – are these pesticides still used or is there an unknown pathway into the Black Harrier population?
- For PCBs (used in electrical transformers) a possible pathway was uncovered – nests with higher densities of electrical transformers within a 5 km radius showed significantly higher levels of contamination. The transformers may be leaking PCB oils into the environment.
- Sub-lethal effects of these pollutants were picked up in assays of stress hormones for chicks and adults indicating high Heterophyl to Lymphocyte white blood cell ratios. This suggests that the immune system is compromised at high PCB levels.
- This also had a knock-on effect in the carotenoid colouration of the cere and tarsi

Once the adults were measured, weighed and sampled, they were released within 20-30 minutes (Photo: Rob Simmons).

for chicks and adults. Individuals with high PCB levels showed paler, less rich yellow colouration, which is known to be an important signal of health and vigour in harriers.

Highlights:

- Marie-Sophie graduated with a PhD in July 2017 and has had five papers published in high impact factor peer-reviewed journals.

Impact of the project

Marie-Sophie's findings suggest that despite 50% of the Black Harrier population occurring in protected areas, the species is under pressure from the genetic to the population level and conservation action is critical if the species is to survive. These findings were recently presented to BirdLife South Africa and the Endangered Wildlife Trust, and an Action Plan is being implemented with both organisations to:

(i) highlight to Eskom the need to replace leaking transformer boxes throughout the range of this species; (this will benefit other raptor species too)

(ii) focus conservation efforts in the most productive coastal breeding areas and over-summering areas in high occurrence areas of Lesotho and the highveld grasslands – these might be IBAs or new areas identified through Maxent modelling;

(iii) reduce fragmentation of pristine fynbos habitat as one of the chief limiting factors from previous work in this programme;

(iv) understand what is the source of the DDT contamination in the Western Cape and reduce its impact through legislation or better monitoring.

If any or all of these conservation initiatives can be achieved, then the Black Harrier's bleak future could be turned around.

Key co-sponsors

National Research Foundation; Golden Fleece Merinos; BirdLife South Africa, Tygerberg Bird Club.

Research team

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Pablo E. Camarero (CSIC, Spain)
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Marlie Martins (Birds & Bats Unlimited)

Student: Marie-Sophie Garcia-Heras (PhD, UCT)

Southern Ground-Hornbill conservation

Southern Ground-Hornbills *Bucorvus leadbeateri* are large, group living birds which require large territories and relatively undisturbed areas with large, old trees that have suitable breeding cavities. These two requirements are increasingly rare given the high rates of habitat destruction that have been ongoing for over a century and have accelerated in recent decades. Southern Ground-Hornbills (SGH) have experienced a two-thirds reduction in their national range, and presumably population size, in the past 100 years and are thus considered globally Vulnerable, having been up-listed to Endangered in South Africa. A long-term study at the Fitz, initiated in 2000, has been investigating their habitat use, reproductive success, natal and breeding dispersal.

One of the main aims of this study was to assess whether artificial nest cavities were an alternative to natural cavities, which have become increasingly scarce. This project is also closely linked to the Mabula Ground-Hornbill Project (MGHP) and the national Ground-Hornbill Action Group who are our partners in implementing the national SGH Species Recovery Plan. The main study area is the Associated Private Nature Reserves (APNR), covering some 200 000 ha adjacent to the central Kruger National Park, and supporting over 20 ground-hornbill groups, of which 12-15 regularly attempt to breed. We have reproductive histories spanning a decade and have found that breeding success increases with group size and the amount of open habitat within 3 km of the nest site. A current focus is on obtaining a better understanding of the species' social structure and individual contributions to breeding success and territory defence.

PhD student Kate Carstens graduated in December 2017 with a thesis on the effectiveness of artificial nests as a conservation tool. Kate found that artificial nests are readily used by the birds, significantly increasing the breeding population in the study area. Additionally, Kate's research provided valuable insights into dispersal strategies of these birds, showing that, although males remain in the natal group for much longer than females, overall dispersal rates are similar for both sexes, unlike what was previously believed. The settlement decisions following dispersal appear to arise from opportunity rather than searching for a better territory, as neither territory quality nor group size affected settlement decisions.

While long-term data collection will continue to address unresolved questions such as what governs dispersal decisions, a new project is focusing on providing a better understanding of this species' social structure. Kyle-Mark Middleton started an MSc study to investigate how individual group members contribute to vital group functions, such as territory defence and reproduction, two poorly understood topics. The project, supervised by Claire Spottiswoode and Rita Covas, has a strong emphasis on understanding the role of group vocalisations on territory defence. For this, Kyle will work with Fanny Rybak, an acoustics' expert from the University of Paris-Sud, France.

Activities in 2017

- Kyle Middleton registered at UCT for an MSc, researching the breeding behaviours and vocalisations of the groups in the APNR.
- Carrie Hickman was appointed as a field assistant to help with the behavioural research and to continue the monitoring of breeding activity and foraging habits.
- Vocalisations of 11 breeding groups were recorded throughout the APNR during their daily morning chorus.
- Initial analysis of the vocalisations suggest that different territorial groups have unique 'signatures'.
- Increased efforts were made to identify individuals by non-invasive techniques such as the use of camera-traps to photograph the birds' face and obtain distinctive individual features of their bill or cask shape, red pouch, 'side-burns', etc.
- Camera traps were placed close to the nest

Figure 1. Photo from the camera trap at Karan Khayai nest.

entrances of three nests. The cameras were placed inside boxes that were built for extra camouflage and placed in the field before the breeding season began. The cameras take three photos along with a 30 second video of the birds when they go into the nest to provide food.

- Genetic samples from known individuals, including incubating alpha females, continue to be collected through non-invasive methods, such as from moulted feathers, the collection of fresh faeces when following groups and at roosts, and by swabbing eggs. This is to determine relatedness between individuals and how this influences investment in cooperative behaviour.

Highlights:

- Kate Carstens was awarded a PhD for her thesis titled 'Nest boxes as a conservation tool for the Southern Ground-Hornbill *Bucorvus leadbeateri*'.
- Kate presented a paper at the International Hornbill Congress held in Borneo in May.
- The second Southern Ground-Hornbill population and habitat viability assessment (PHVA) workshop was held at Mabula Private Game Reserve in August 2017. Nationwide actions were set in motion to conserve the species.
- The 2016/17 season saw 14 active nests with eight chicks successfully fledged, and four second-hatch chicks were harvested for the wild-release programmes.
- Since 2000, 98 chicks have fledged from artificial nests in the APNR, contributing 38 second-hatched chicks for the species' Reintroduction Plan.
- Thornybush Nature Reserve became part of the APNR, expanding the study area by 11 000 ha.
- A new active natural nest was discovered on Thornybush Nature Reserve.
- Ongoing repairs to and replacement of artificial nest boxes ensure that ground-hornbills can continue to thrive in an area which has a paucity of natural nest cavities.
- Six new artificial nests were installed, of which three were used by hornbills. One of these nests saw the first breeding attempt for a group of birds located on Jejane Private Nature Reserve.

Impact of the project

This project has provided a significant contribution to the demographic gains of the SGH population at the APNR as a result of the deployment of artificial nests in the reserve. More generally, the project has demonstrated the efficacy of these nest boxes as a conservation tool, particularly in areas that have a shortage of large trees with natural cavities. These results contributed to the national SGH Species Action Plan and to the SGH Reintroduction Plan and assist with the implementation of these plans. Rob Little and Kate Carstens represent the Fitz on the national SGH Action Group while Rob is also Vice Chairman of the MGHP management board. During 2017, the project gave seven presentations to the general public to help create awareness and published an article in the local magazine *Klaserie Chronicle* which is distributed to surrounding private reserves and the greater Hoedspruit community.

Key co-sponsors

The Foundation for Science and Technology FCT, Portugal; Associated Private Nature Reserves; Dow Southern Africa (Pty) Ltd; Senelala Estates.

Research team

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

Students: Kate Carstens (PhD, UCT); Kyle Middleton (MSc, UCT).

Research Assistant: Carrie Hickman.

Saving Cape Parrots and their forests

The Cape Parrot *Poicephalus robustus* has been confirmed to be a separate species which is endangered and endemic to a few Afromontane forest patches in South Africa. With fewer than 1 500 individuals remaining in the wild, it is threatened by a diversity of impacts ranging from habitat loss to illegal trade and disease. Tackling this array of threats makes it a useful model for developing and testing different research and conservation strategies, and it is a valuable flagship species for conserving South Africa's Afromontane forests.

The Cape Parrot Project (CPP), which started in 2009, aims to conserve the endangered and endemic Cape Parrot through research, education and reforestation efforts. This is a partnership with government, local community stakeholders, conservation partners and research collaborators.

Activities in 2017:

- The CPP reforestation programme continued dealings with relevant policy stakeholders (e.g. Department of Agriculture, Forestry and Fisheries (DAFF), Eastern Cape Parks and Tourism Agency) to proclaim forest reserves, reduce yellowwood harvesting, secure planting sites, and engage with rural communities.
- We continued monitoring and recording data on the foraging, breeding and movements of Cape Parrots in Hogsback and surrounds, as well as on indigenous fruiting trees within the forest, and maintained and inspected artificial nest boxes.
- Six community staff members, Dumisani Sohobo, Bulelani Velemu, Sakhikile Mabaso, Siyabulela Sonjani, Wanda Limba, and Willie Mafika, attended courses and received training on environmental conservation, and best planting and growing practices for regenerating indigenous trees.

Research Highlights:

- The CPP expanded a comprehensive research database with observational data which has increased our knowledge on the seasonality of diet, flocking behaviour, distribution and movements of Cape Parrots with respect to changes in food availability and climatic conditions.
- Five natural nest sites were located. One nest could be inspected, with eggs confirmed. This is the first time the project has been able to locate and monitor these nests.
- The research team recorded the largest ever flock of Cape Parrots (~600 recorded in Alice pecan nut orchard).
- The team captured and sampled parrots for Psittacine Beak and Feather Disease (PBFD) testing.
- Rarely observed behaviours of Cape Parrots were documented: (1) first record of copulation behaviour, (2) drinking water from oak leaves, (3) eating acorn nuts for the first time, and (4) rubbing beaks on and consuming lichen, which may act as a detox during the pecan nut season.
- The public were increasingly engaged and are helping with data collection via citizen science apps such as BirdLasser. In addition, there is an established "spotter network" in the Amathole mountains where sightings are noted and entered into our growing database to inform conservation on the ground.
- Three scientific papers on the courtship displays and mating behaviour of Cape Parrots, interactions between birds of prey and the Cape Parrot, and the use nest boxes for Cape Parrots were published. Four other papers are in preparation.
- Collaboration continued with Prof. Anna Young from Otterbein University, USA, on Cape Parrot vocalisations. Two volunteer students accompanied the team who travelled to Magoebaskloof in the Limpopo Province, the Creighton area in the KwaZulu-Natal Midlands, and the Wild Coast (Old Transkei) of the Eastern Cape to monitor and record vocalisations of Cape Parrots.
- A paper titled "Evidence for vocal dialects in the endangered Cape Parrot" was presented at the Animal Behaviour Society conference held in Toronto, Canada.

- Media coverage of the CPP by two journalists: Janine Stephen from *Getaway* (November 2017 issue) and Christine Dell'Amore from *National Geographic* (to be published in 2018 as part of the Year of Birds feature).

Reforestation highlights

- Over 40 000 seeds from native tree species were collected from the forests, and the climate-controlled germination room continues to run successfully.
- We established a community run nursery in Sompondo Village, with 16 micro-nursery staff, including a nursery manager. The CPP provided training and built the nursery, storage shed and secured water. The CPP provides the nursery with seeds and buys back seedlings grown.
- The CPP entered into a partnership with DAFF, where CPP has been given government land to reforest with locally grown indigenous seedlings.
- We entered into a partnership with the NGO Greenpop and local business Terra Khaya for "Festival of Trees", an annual event. 1 500 trees were sold; half planted on DAFF land and half on private land in Hogsback.
- Indigenous seedlings were planted at two sites in Hogsback: over 600 seedlings as a "feed lot" for parrots on municipal land in partnership with two local businesses and the other on DAFF reforestation land in partnership with Greenpop and Terra Khaya. To date, 35 000 indigenous seedlings have been planted in 21 sites around Hogsback.
- The CPP is collaborating with DAFF to monitor indigenous yellowwood harvesting, exotic pine plantation industry and promote indigenous forest reserve proclamation.

Impact of the project

By learning more about Cape Parrots, we are able to better conserve the species. For instance, by understanding the characteristics of natural nest cavities (e.g. position, type of tree) we can improve the use of artificial nest boxes. Finding where they travel in different seasons and the indigenous tree species they rely on for fruit gives us a better idea of areas that need to be protected and incorporated into reserves. Increased capacity to grow trees allows us to populate degraded habitat with indigenous trees for use by forest species, particularly Cape Parrots.

A Sompondo village community micro nursery grower with her seedlings.

New nursery (black shade cloth) next to existing nursery on Boscobel, Hogsback (Photos: Nikki Steyn)

Key co-sponsors

Abax Foundation; Ford Wildlife Foundation; Roland and Dawn Amall Foundation.

Research team

Dr Steve Boyes (FIAO, UCT, Project Director)
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Dr Rob Little (FIAO CoE Manager, Wild Bird Trust Trustee)
Dr Kate Carstens (Wild Bird Trust, project coordinator)
Cassie Carstens (Wild Bird Trust, research manager)
Dr Helen Fox (Wild Bird Trust, reforestation manager)
Nikki Steyn (Wild Bird Trust, nursery manager)

Conserving Benguela endemic seabirds

All three seabirds endemic to the Benguela upwelling ecosystem that rely on anchovies and sardines are threatened by a reduction in the availability of their preferred prey. Small pelagic fish have greatly reduced in abundance off the southern African west coast, where fishing effort is concentrated and most seabird breeding islands are located. Fish stocks have increased off the south coast, where fishing pressure is low but there are very few suitable bird breeding locations. The main challenge is to ensure adequate spatial management of this fishery. To this end, it is important to understand how the at-sea distribution of seabirds overlaps with fish distribution and fishing effort.

However, not all seabirds in the region are decreasing. Greater Crested (or Swift) Tern *Thalasseus bergii* numbers have increased over the last few decades, despite feeding on the same small pelagic fish prey as the African Penguin *Sphensicus demersus*, Cape Cormorant *Phalacrocorax capensis* and Cape Gannet *Morus capensis*. And it is not only these species that depend on small pelagic fish that are in trouble. Populations of Bank Cormorants *Phalacrocorax neglectus*, which feed on a diverse array of demersal prey, also have decreased along the South African west coast, but increased locally along the south coast. Understanding the drivers behind these population changes is the crucial first step necessary to mitigating population 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 (Ross Wanless, Christina Hagen, Taryn Morris) and DEA (Azwianewi Makhado and Rob Crawford), as well as several post-doctoral students.

Activities in 2017

- After completing his PhD at the Fitz, Alistair McInnes took up a post-doctoral position at NMU to study the use of seabirds as real-time monitors of pelagic fish availability. Working mainly at Stony Point, Betty's Bay, home to the only increasing population of African Penguins, he is using cameras and GPS loggers to see how hard penguins have to work to catch prey.
- Another NMU postdoc, Dr Giannina Passuni, worked with Lorien Pichegru and NMU's Nadine Strydom to investigate the stomach contents of anchovies eaten by African Penguins to understand the diet of the penguins' main prey. She is also investigating water quality and plankton abundance around St Croix Island. She will link her results to oceanographic data from SAEON to understand how environmental conditions affect pelagic fish and their prey.
- The experimental closure of commercial fishing for small pelagic fish around key penguin breeding islands continued in 2017. In Algoa Bay, penguins breeding on St Croix Island again decreased their foraging effort during closures. Richard Sherley's paper in *Proceedings of the Royal Society* suggested that high environmental variability between years and colonies made it hard to demonstrate benefits of closures on penguin chick condition, and advocated controlling for environmental conditions to pin-point the effect of the closures. Despite this, the

NMU postdoc Dr Giannina Passuni collecting water samples from St Croix Island, helped by PhD student Mfundo Bizani (Photo: Lorien Pichegru).

More aggressive African Penguins may provide less food to their young, as they spend more energy defending their nests (Photo: Lloyd Edwards).

Department of Agriculture, Forestry and Fisheries decided to re-open St Croix Island to fishing for 2018-2020.

- PhD student Gwendoline Traisnel published on African Penguin personalities in *Ethology*. Individual penguins vary in how they respond to a human intruder, with shy birds tending to be better parents than more aggressive birds, especially when food is scarce. Aggressive individuals may spend more energy defending their nests, limiting their investment in foraging effort.
- Gwendoline also published a note in *Marine Ornithology* about plumage aberrations in African Penguins. Few individuals are resighted across years, suggesting potentially high adult mortality.
- Lorien Pichegru's new PhD student Katharina Reusch (NMU) started a project investigating the foraging ecology of Kelp Gulls *Larus dominicanus*. With visiting scientist Dr Nicolas Suarez from the Centro Patagonico in Argentina, she deployed GPS recorders and collected stomach samples from incubating Kelp Gulls from colonies varying in their access to human-produced food. Her preliminary findings reveal a wide variety of food items, independent of the distance to towns or refuse dumps.
- Pierre Pistorius continued to study Cape Gannets, collecting tracking and demographic data at the Bird Island colony in Algoa Bay. Post-doctoral student, Andrea Thiebault, deployed tiny microphones and video-recorders on some tracked birds to study at-sea acoustic communication.
- Danielle Van Den Heever completed data collection on the at-sea habitat use by Wedge-tailed Shearwaters *Ardenna pacifica* breeding at Reunion and the Seychelles.
- Illana Engelbrecht started a MSc with Pierre Pistorius on foraging strategies and within-pair synchronization in Cape Gannets at Bird Island. The project is based on the extensive set of foraging trip durations of individuals tagged with VHF transponders.
- David Grémillet and Lorien Pichegru continued their long-term study of Cape Gannets breeding on Malgas Island. In recent years, most adult gannets provisioning chicks spend more energy than they gain through foraging, with long-term fitness cost. In 2017,

Kelp gulls prey on other seabird nests on breeding islands (Photo: Peter Ryan).

they deployed GPS on individuals of known-age to explore how experience influences foraging success.

- Lorien Pichegru highlighted the very high levels of predation on the Cape Gannets breeding on Malgas Island. Kelp Gulls and Cape Fur Seals *Arctocephalus pusillus* have unsustainable impacts on the population and need active management.

Highlights:

- Davide Gaglio was awarded his PhD, and published papers on the diet of Greater Crested Terns (*PLoS One*), their ability to catch multiple prey (*Ostrich*) and the impact of kleptoparasitism when breeding with and without Hartlaub's Gulls *Chroicocephalus hartlaubi* (*Behavioural Ecology*).
- Alistair McInnes's paper in the *Proceedings of the Royal Society, London* demonstrated that penguins foraging in groups on bait balls had increased catch rates compared to birds foraging individually. This paper attracted widespread media coverage, including in *New Scientist*.
- A paper from Alistair's PhD published in *Marine Ecology Progress Series* showed that penguins from Bird Island, Algoa Bay, exploit an upwelling cell of high localised productivity, helping to offset the impacts of fishing activity on this colony.
- Lorien Pichegru's findings on the impacts of seismic surveys on African Penguins published in *Scientific Reports* may have wide implications, as seismic surveys are increasing globally in frequency and intensity, with limited understanding of their impact on seabirds.
- Richard Sherley's paper on the threats facing Bank Cormorants was published in the leading conservation journal, *Conservation Biology.*
- Several students presented papers or posters at the 16th South African Marine Sciences Symposium in Port Elizabeth in July and at the 6th Bio-logging Conference in Hamburg in September.
- Pierre Pistorius coordinated a well-attended workshop at the South African Marine Science Symposium on seabird and seal research within the Benguela region. The main aim was to develop an inventory of all tracking data within the region which will be used in future studies to identify Ecologically and Biologically Significant Areas (EBSAs) for conservation-based marine spatial planning.
- Ex-CoE student, Gavin Rishworth, published a synthesis of his MSc work on time-activity budgets in Cape gannets in the *Journal of Marine Systems*.
- MSc student Jonathan Botha graduated with distinction for his thesis comparing the foraging behaviour of Cape Gannets during the guard and post-guard phases. He reported some spatial and temporal segregation between the sexes in *Marine Ecology Progress Series*.

Key co-sponsors
BirdLife International; BirdLife South Africa; DST-NRF CoE grant; Raggycharters Whale Watching.

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Dr Jon Green (U. Liverpool)
Dr David Grémillet (FIAO, UCT and CNRS)
Dr Azwianewi Makhado (Oceans & Coasts, DEA)
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Dr Lorien Pichegru (NMU)
Dr Pierre Pistorius (NMU)
Dr Richard Sherley (U. Bristol)
Dr Ross Wanless (FIAO, UCT and BLSA)

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Disturbing the peace

Human population densities are greatest in coastal areas and around wetlands. As a result, many coastal and water birds face significant threats from direct human disturbance. Some species appear to be able to tolerate disturbance, whereas others are decreasing in numbers. A key question is how tolerance develops among populations; is it learned, or is it the result of selection for more tolerant individuals? This programme assesses the impacts of disturbance and development on coastal and water birds, and devises practical methods to minimise the impacts of tourism on coastal-breeding shorebirds.

White-fronted Plovers (Photo: Peter Ryan)

This programme had only one active project in 2017. PhD student Selena Flores completed her field work on the role of disturbance in driving population decreases in coastal populations of White-fronted Plovers *Charadrius marginatus*. Working with the Nature's Valley Trust (NVT) in the Garden Route area, the main focus in 2017 was on devising effective measures to reduce the impacts of coastal tourism on this vulnerable shorebird species. Although Selena's field work stopped after the 2016/17 breeding season, research staff and volunteers from the Nature's Valley Trust continued to implement mitigation measures through the 2017/18 season, and to monitor the impact of these measures on White-fronted Plover breeding success.

Activities in 2017

Selena Flores monitored White-fronted Plovers on the coast around Plettenberg Bay for the third breeding season in succession. She is testing how plover breeding behaviour differs over a disturbance gradient. Selena's results from the first field season with a conservation intervention program running were encouraging. On the two beaches at Nature's Valley where information boards, nesting area signs, brochures and active public engagement occurred, breeding success almost doubled from 8.6% to 15.2%, but the increase at Plettenberg Bay's Lookout Beach was much more modest, from 10.6% to 12.7%. Breeding success at both sites remains worryingly low. Strong stakeholder engagement, driven by the NVT team, saw changes to beach management of dogs formalised late in 2017, with beaches now zoned from dogs off leash (green), on leash (orange), or no dogs allowed (red), based on the project's bird breeding data.

Highlights:

- Andrew de Blocq completed his MSc exploring the possible impacts of boat-based tourism at De Hoop Nature Reserve and graduated in mid 2017.
- PhD student Selena Flores completed her field work in 2017. She presented some of her findings at the Western Hemisphere Shorebird Group meeting in Peru in November 2017.

Key co-sponsors
BirdLife Plettenberg Bay; Cape Nature; DST-NRF CoE grant; Keurboomstrand Property Owners' Association; Knysna Toyota; Table Mountain Fund; Hans Hoheisen Charitable Trust, Wader Quest.

Research team
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Dr Mark Brown (Nature's Valley Trust)
Dr Robert Thomson (FIAO, UCT)

Students: Andrew de Blocq (MSc, UCT), Selena Flores (PhD, UCT)

Research assistants: Brittany Arendse, Jesse Beck, Taylor Frederichs, Aurora Hood, Christina Marques; Anathi Mbona; Sabine Meurens; Claire Gaudart-Wifling; Liezl Retief.

Conserving Southern Ocean seabirds

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

Most field work takes place through the South African National Antarctic Programme (SANAP) at the Prince Edward Islands, Tristan da Cunha and Gough Islands. Some students spend protracted periods on islands as field assistants, whereas others are based in South Africa. Fitztitute seabird research on Marion Island, the larger of the two Prince Edward Islands, has continued unbroken since the early 1980s, when a series of long-term seabird study colonies were established by John Cooper. The three-year research project that focused on understanding the threats facing sooty albatrosses *Phoebetria* spp., and investigating how large, long-lived seabirds tradeoff the costs of moult and breeding, comes to an end in April 2018. Although there will be no dedicated Fitz seabird project in the coming three-year cycle, the long-term studies will be continued through three collaborative projects with CoE team members at Nelson Mandela University (Pierre Pistorius and Maelle Connan) and DEA (Azwianewi Makhado). This project overlaps with the island conservation project (see p. 43).

Activities in 2017

- PhD students Dom Rollinson and Otto Whitehead both completed their theses and each published one paper during the year under review: Dom summarised bycatch in the South African tuna fishery over the last 8 years in the *African Journal of Marine Science*, and Otto reported where Macaroni *Eudyptes chrysolophus* and Southern Rockhopper Penguins *E. chrysocome* forage during the crucial pre-moult period in *Marine Ecology Progress Series.* Otto also accompanied renowned photographer Thomas Peschak to Marion Island in April-May 2017 and the island's birds will feature prominently in an article in *National Geographic* in mid-2018.
- Four other papers based on seabird tracking data were published: one on sooty albatrosses from Marion, Gough and Tristan (Schoombie et al. *Emu*), one on Atlantic *Pterodroma* petrels (Ramos et al. *Diversity & Distributions*), and two using tracking data from a diversity of seabirds to define important areas for marine conservation (Krüger et al. *Animal Conservation,* Dias et al. *Biological Conservation*).
- Stefan Schoombie registered for a PhD on fine-scale foraging behaviour of albatrosses and petrels, co-supervised by Rory Wilson and Yan Ropert-Coudert. He visited Marion Island during the relief voyage in April-May 2017, when he deployed miniature video cameras that he developed on Wandering Albatrosses *Diomedea exulans*, together with some of Rory's 'daily diary' loggers. Additional loggers were sent to Gough Island for deployment later in the year. He also found time to assist Rob Ronconi write up satellite tracking data on Great Shearwaters *Ardenna gravis* from almost a decade ago (in press with *Marine Biology*) and analyse GPS tracks from this species collected more recently by Ben Dilley and Delia Davies.
- Kim Stevens made steady progress towards her PhD on Grey-headed Albatrosses *Thalassarche chrysostoma*, aided by attending a population modelling course in Washington, DC and a visit to Sarah Converse's lab in Oregon. She also prepared a draft paper on the at-sea dispersal of Atlantic Yellow-nosed Albatrosses *T. chlororhynchos*.
- Despite going to Marion Island as a field assistant in April 2017, MSc student Chris Jones (Gough Island field assistant 2014/15) made good progress with writing up his MSc on the two sympatric species of prions *Pachyptila* breeding on Gough Island. His analysis of their movement and activity patterns based on GLS deployments confirms that the two species breed 3 months apart, with the annual cycle of Broad-billed Prions *P. vittata* two weeks earlier at Gough Island than at the Tristan group (where it is the sole breeding prion), possibly because of intra-specific competition.
- Chris, accompanied on Marion by his wife, Michelle Risi, not only managed the standard

workload, but also undertook a series of other projects, including clearing Santa Rosa Valley to assess the rate of albatross mortality caused by crashing on the rugged black lave flow, and counting the Brown Skua *Chatharacta antarctica* breeding population to assess whether the species' decline from the mid-1990s to mid-2000s has continued over the last decade.

- Ditiro Moloto, one of the original cohort of Limpopo students who came to the Fitz as an exchange student in 2014, completed the data capture phase for her MSc on the structural adaptations of flight feathers for flight underwater in procellariiform seabirds, and should submit her dissertation in early 2018.
- Former Marion Island field assistant Alexis Osborne registered for an MSc on the impact of breeding status on moult in Wandering Albatrosses and giant petrels. He collected additional data for this project on the annual relief voyages to Marion and Gough Islands, and also went to SANAE as a field assistant for DEA.
- Res Altwegg's PhD student, Gordon Botha, took a leave of absence from his PhD on patterns of survival and breeding propensity in Wandering Albatrosses at Marion Island to deal with personal commitments.

Highlights:

- Dominic Rollinson received a PhD for his work showing how mitigation measures continue to reduce bycatch in the long-line fishery targeting tunas and swordfish off South Africa, with the Asian fleet that has 100% observer coverage managing to catch at around the recommended target of 0.05 birds per 1000 hooks set.
- Otto Whitehead received a PhD for his study of the comparative foraging ecology of Macaroni and Southern Rockhopper Penguins on Marion Island.
- Peter Ryan was field leader of a project proposed by Henri Weimerskirch (CNRS) for the Antarctic Circumnavigation Expedition (ACE) from Dec 2016 to Mar 2017. This has already resulted in one published and three in press papers, including one on the dispersal of drifting kelps across the Antarctic Polar Front in the prestigious journal *Nature Climate Change*.
- Nine papers on Southern Ocean seabirds and their conservation were published in 2017, and a further seven are in press in 2018.
- Peter Ryan's popular book *Seabirds of southern Africa*, was published in March and launched aboard BirdLife South Africa's *Flock at Sea* cruise in April 2017.

Vonica Perold and Alexis Osborne spread the wing of a Wandering Albatross for photographs for Alexis' study on moult in breeding Wandering Albatrosses and Giant Petrels (Photo: Daniël Kotze).

Key co-sponsors

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

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Dr Theresa Burg (U. Lethbridge, Canada)
Dr Maelle Connan (NMU)
Dr Sarah Convese (Oregon)
Dr Rob Crawford (Oceans & Coasts, DEA)
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Prof. Rory Wilson (Swansea U.)

Students: Gordon Botha (PhD, SEEC, UCT) Dominic Rollinson (PhD, UCT), Kim Stevens (PhD, UCT), Otto Whitehead (PhD, UCT), Chris Jones (MSc, UCT) Ditiro Moloto (MSc, UCT), Alexis Osborne (MSc, UCT).

Conserving islands and their birds

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

This programme is mainly concerned with the impacts of introduced predators, especially House Mice *Mus musculus*, but also is involved in the eradication or control of introduced plants at Gough Island and the uninhabited islands in the Tristan archipelago, as well as documenting the impacts of invasive invertebrates at these islands. 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, they have been found to attack seabird chicks on Marion Island, and plans are underway to try to eradicate the species at both islands.

Activities in 2017

- Regular surveys were conducted from March to May 2017 to monitor the spread of mouse attacks on large chicks of Grey-headed Albatrosses *Thalassarche chrysostoma* and sooty albatrosses *Phoebetria* spp. at Marion Island. Fewer birds were attacked than in 2015 and 2016, but the spatial extent of attacks was equally widespread as in previous years.
- Emma Witcutt and David Kinchin-Smith reported the first evidence of mice 'scalping' Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos* chicks at Gough Island during the 2016/17 breeding season.
- Field assistant Michelle Risi and MSc student Chris Jones, conducted a series of toxicity trials on mice on Marion Island to ensure that all mice that eat poison bait die. In fact they found that some mice survived when fed half a pellet, so additional trials are planned for 2018 with higher concentrations of the toxin brodifacoum. Michelle and Chris also conducted snap trapping near sea level, 300 m and 600 m to assess the decrease in mouse densities with elevation, which is crucial for planning baiting densities across Marion Island. They also monitored cloud heights around Marion over the winter to give some idea of the frequency of days with sufficient visibility for baiting by helicopter to take place.
- Ben Dilley and Delia Davies completed their first field season on Nightingale Island in early 2017 as part of an EU-BEST project awarded to Tristan Conservation to collect basic biology information on the Endangered Wilkins' Bunting *Nesospiza wilkinsi*. They returned to Nightingale in September 2017 to obtain a second year of breeding data, as well as to re-sight as many banded buntings as possible for mark-recapture survival estimates.
- An unfortunate discovery during Ben and Delia's second visit was the widespread presence of the invasive greedy scale *Coccus hesperidum* and localised infestations of its associated sooty mould *Seiridium phylicae* at Nightingale Island. Prior to this there was only a single record of the scale insect from Nightingale. The insect and sooty mould

A Wilkens' Bunting flies off a *Phylica* tree branch (Photo: Ben Dilley).

together significantly reduce the amount of *Phylica* fruit produced on infected trees, which has potentially serious implications for Wilkins' Buntings that rely to a large extent on *Phylica* fruits for food.

- *Sagina procumbens* control/eradication operations continued on Gough Island throughout 2017. The new regime spraying with a combination of pre-emergent and standard herbicides appears to be making a difference, with decreasing numbers of seedlings detected in successive summers.

Highlights:

- During 2017 the RSPB finally announced that an eradication attempt for mice on Gough Island would take place in 2019. The plan will be supported logistically by the South African Department of Environmental Affairs (DEA).
- The donation of three helicopters and $100,000 to DEA by the Mamont Foundation, following the Antarctic Circumnavigation Expedition in March 2017, has stimulated DEA to announce plans for an eradication attempt on Marion in 2020, if the Gough eradication goes ahead as planned in 2019.
- A fund-raising programme to support the eradication of mice on Marion Island was initiated during BirdLife South Africa's Flock at Sea cruise in April 2017, which attracted close to 2 000 birders.
- Dr Guy Preston from DEA presented a paper co-authored by Ben Dilley and Peter Ryan, reporting the impact of mice on Marion Island's biota and indicating South Africa's intent to launch an eradication for mice on Marion Island at the Third Island Invasives Conference in Dundee during July 2017.
- PhD student Otto Whitehead accompanied photographer Thomas Peschak to Marion Island in April-May 2017 and the impact of mice on the island's birds will feature prominently in an article in National Geographic in mid-2018.
- Ben Dilley published a paper in *Antarctic Science* reporting how mice are causing low breeding success among burrowing petrels on Marion Island.
- The paper led by Airam Rodriguez, with Peter Ryan as one of many co-authors, reviewing the impact of light pollution on seabirds, primarily at their breeding islands, was published in *Conservation Biology*.
- Michael Brooke's meta-analysis on the recovery of seabird populations following restoration programmes, with Ben Dilley and Peter Ryan as co-authors, was selected to be the main paper in an issue of *Animal Conservation*, with invited contributions from three leading restoration scientists and a response from the paper's authors.
- Two papers on the clinical pathology of the endemic land birds of Gough Island, the Gough Bunting *Rowettia goughensis* and Gough Moorhen *Gallinula comeri*, were published in the *Journal of Comparative Pathology*. The studies, led by Mark Dagleish from the Moredun Institute in Scotland, forms part of the preparation for taking insurance populations of buntings and moorhens into captivity during the mouse eradication attempt on Gough Island planned for the winter of 2019.

Alexis Osborne inspects a dead Tristan Albatross chick on Gough Island (Photo: Peter Ryan).

Key co-sponsors

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

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Trevor Glass (Tristan Conservation Department)
Dr Ross Wanless (FIAO, UCT and BLSA)

Student: Ben Dilley (PhD).

Research assistants: Emma Witcutt, David Kinchin-Smith and Phil Lambdon (Gough 2016/17), Jaimie Cleeland, Kate Lawrence and Fabrice Lebouard (Gough 2017/18), and Delia Davies (Nightingale).

Hot Birds – Climate change and desert birds

The 'Hot Birds' project integrates behavioural and physiological approaches to develop predictions of how climate change is affecting birds that inhabit arid habitats in southern Africa and globally. The main focus of the Hot Birds project is bird communities of the Kalahari Desert, but we also work in a range of other non-desert habitats and arid regions of North America and Australia.

Fitness and the importance of behaviour

The UCT branch of the Hot Birds Team focus on understanding the links between temperature, behaviour and fitness. Since 2010, we have shown that many bird species face temperature thresholds/inflection points around mid-30°C, above which they experience sublethal fitness costs. These costs include reduced foraging success in Southern Fiscals *Lanius collaris*, Southern Yellow-billed Hornbills *Tockus leucomelas*, Southern Pied Babblers *Turdoides bicolor,* Fork-tailed Drongos *Dicrurus adsimilis*, accompanied by inability of adults to maintain body mass (hornbills and pied babblers); declines in nestling provisioning rates (hornbills, fiscals and drongos), growth rates of nestlings, size and quality of fledglings, and fledging success (hornbills and fiscals). The underlying mechanism driving these sublethal fitness costs appears to be behavioural trade-offs made by adults to minimise exposure to the physiological costs of high temperatures. These trade-offs result in lost foraging opportunities through reductions in activity and their use of shaded locations suboptimal for foraging (fiscals, hornbills, drongos); and/or handicaps on foraging efficiency imposed by the use of respiratory evaporative cooling (babblers and hornbills).

In 2017, the team continued research into the mechanisms underlying these patterns, to improve our ability to predict the vulnerability of a wide range of arid zone species to ongoing climate change. Susie Cunningham travelled to Australia to forge a collaboration with Dr Janet Gardner at the Australian National University to expand this research into the Australian arid zones. Projects with Janet may include studies of the impacts of temperature on foraging and breeding success in species such as Jacky Winter *Microeca fascinans* and Chirruping Wedgebill *Psophodes cristatus,* as well as broader-scale comparative studies with ground foraging birds. Janet was awarded an Australian Research Council grant to fund some of these projects.

In December 2017 we engaged Nick Pattinson as a field assistant, to continue the long-term monitoring of changes in breeding success and ultimately population dynamics of Southern Yellow-billed Hornbills at Kuruman River Reserve. Nick will register as a PhD student at UCT in 2018, focussing on the physiological mechanisms underlying the correlations between temperature and breeding outcomes documented by PhD student Tanja van de Ven, including aspects of stress and immune physiology, feather quality and carry-over effects. Nick will also try to disentangle the effects of drought and concomitant low food availability from the effects of high air temperatures using a supplementary feeding experiment. Nick has a long history with the Hot Birds project, having completed his honours with Andrew McKechnie at UP and his MSc with Ben Smit at NMU.

The buffering effects of sociality

PhD student Amanda Bourne completed her third summer of fieldwork studying the ways in which cooperative social behaviour could buffer the fitness costs of high temperatures. Amanda works with 20 groups of habituated Southern Pied Babblers on the Kuruman River Reserve. The babblers are cooperative breeders with a natural variation in group size that makes them an ideal model species to study the effect of cooperation on physiological costs of heat stress and fitness costs of behavioural thermo-regulation. Amanda has validated a non-invasive technique for measuring field metabolic rate using doubly-labelled water with oral dosing and faecal sampling, removing the need to capture and handle study animals. Data collection in the field using this technique will allow the team to correlate daily energy expenditure with individual time budgets and foraging success in addition to environmental conditions. Preliminary data from measure-ments of nestling daily growth rates suggest profoundly negative consequences of heat stress

on nestling development and survival, regardless of group size. In addition, monitoring of breeding attempts has revealed that 'hot nests' are half as likely to hatch as those incubated during cooler periods. Amanda will also use the 15 year Pied Babbler Research Project database to investigate the long-term and cumulative consequences of high temperatures on survival and reproduction in Southern Pied Babblers, and the possible influence of group size on these impacts.

Societies and climate change

Postdoctoral fellow Margaux Rat continued her work investigating the impact of climate change on the social structure of group-living Kalahari birds, with a focus on Sociable Weavers *Philetairus socius*. Margaux's work combines correlative field observations with experimental laboratory-controlled approaches to examine the impact of variation in temperature on the nature and frequency of social interactions and ultimately the impact on social networks of Sociable Weavers. Results from the field component of the project suggest that when individuals experience extreme and unstable environmental temperatures, they interact less with their conspecifics. This is reflected in the cohesiveness of their social network: it becomes less dense and breaks down into more separate components. Hence, changes in social network structure appear to be linked to the severity of heat stress experienced by individuals. Climate change models predict an increase in temperature variation, suggesting that social systems may become increasingly vulnerable.

Hot Birds in the southern scrubland biomes

The Hot Birds team made its first foray into the Fynbos biome in 2013, joining forces with Alan Lee and Phoebe Barnard of the Climate Change and Fynbos Birds team, and Nelson Mandela University (NMU) lecturer Ben Smit (formerly a PhD student of the Hot Birds project). Since then, the project has expanded to study the impacts of climate on birds endemic to the three distinct semi-arid scrubland biomes of South Africa; the Fynbos, Nama Karoo and Succulent Karoo. Ben Smit took up a Senior Lecturer position at Rhodes University during 2017.

Krista Oswald registered for a PhD at Rhodes University during 2017 to continue her work on Cape Rockjumpers *Chaetops frenatus* under the supervision of Ben Smit, Susie Cunningham and Alan Lee. Krista undertook trips to various parts of the Cape Rockjumper range to gather blood samples for genetic analysis (over 100 individuals in total), with sampling at Cederberg, Langeberg, Kogelberg, Anysberg, Swartberg, Kammanassie, Kouga, and Groot-Winterhoek, as well as a few Drakensberg Rockjumper *C. aurantius* samples. Krista also completed data collection for one of her PhD chapters on rockjumper behavioural responses to heat. Krista's long-term monitoring of tagged rockjumpers came to great use in publishing a short note in *Ibis* on PIT-tag location and risk assessment in small passerines. This paper showed that while abdominal PIT-tagging was probably low risk to larger passerines, such as rockjumpers (~50 g), smaller passerines (<20 g) may be at risk of injury, and inserting PIT-tags under the skin may be a feasible alternative when obtaining body temperature data. Krista also completed a second year of reproductive data collection from rockjumpers, and it is clear that Boomslang *Dispholidus typus* are a main predator of rockjumper nestlings with only one of 38 chicks fledging from 19 nests in the 2017 season. These snakes are particularly active on warm days, suggesting an unexpected, indirect link between reduced reproductive success and increasing temperatures.

PhD student Krista Oswald drawing a blood sample from a Cape Rockjumper (Photo: Susie Cunningham).

Thermoregulation in the heat

The Hot Birds team is developing a behavioural index of heat stress in birds. Establishing whether functional links exist between inter- and intraspecific variation in heat dissipation

and body temperature regulation was the focus of PhD student Michelle Thompson during 2017. Michelle maintained populations of nine bird species in large outdoor aviaries during the Kalahari summer to examine the interactions between behavioural and physiological thermoregulation. On hot days, most species reduced activity and increased shade-seeking sufficiently to manage heat load without resorting to hyperthermia. Michelle also examined the effect of water availability on thermoregulation in these nine species, with a short-term lack of water causing two passerines (White-browed Sparrow-weavers *Plocepasser mahali* and Cape Glossy Starlings *Lamprotornis nitens*) to maintain lower body temperatures on afternoons when water availability was restricted. In contrast, two columbids (Namaqua *Oena capensis* and Laughing Doves *Streptopelia senegalensis*) increased body temperature when water was not available. Michelle's data reveal that Kalahari species vary substantially in the suite of behavioural and physiological strategies they use to thermoregulate.

White-browed Sparrow-weavers

The recent completion of the Small Animal Physiological Research Facility (SAPRF) at U. Pretoria was a significant milestone for the Hot Birds research group. This state-of-the-art climate-controlled facility allows us to explore the plasticity of avian thermoregulatory responses with insights into the capacity of birds for adaptive physiological responses to changing climates at a level previously not possible. PhD student Matt Noakes has colonies of White-browed Sparrow-weavers at this facility from sites along a temperature and aridity gradient across southern Africa. These birds are housed in three different temperature cycle rooms, with daytime temperatures ranging from 30 to 42°C. This acclimation study investigates the flexibility of heat tolerance in sparrow-weavers, and will specifically determine the source of inter-population differences already documented in this species.

Red Larks:

MSc student Ryno Kemp started his study of the vulnerable Red Lark *Calendulauda burra* in October 2017. His work focuses on understanding the movements and activity patterns of the lark, but also involves characterising their physiological traits in the context of adaptation to arid environments. He plans to measure the metabolic rates, water fluxes and other physiological variables needed to parametrize a mechanistic model in the NicheMapper framework. This cutting-edge approach links the physiology and behaviour of a species to its physical and biotic environment by means of detailed models of energy and water exchanges. The study will put us in a position to better understand the Red Lark's habitat requirements and how the species will respond to climate change, thereby providing the basis for developing and implementing more effective conservation management plans.

Climate change past, present and future

Shannon Conradie began her MSc examining heat stress risk in desert birds under past, present and future climates. Shannon's work uses existing physiological and behavioural data on acute (12 species) and chronic (3 species) heat stress thresholds in southern African desert birds collected by the Hot Birds team over the last eight years. She has modelled maximum and average temperatures during summer months in southern Africa for the last millennium (850 – 1850 AD) and modern times (1850 – 2014). Preliminary results indicate that during recent years the occurrence of environmental conditions associated with both acute and chronic heat stress risk have increased in both time and space. Birds occurring in these areas are facing trade-offs between thermoregulation and foraging efficiency, dehydration and/or maintaining body condition more frequently than what the modelled data for the last millennium suggests. These results highlight the importance of mitigation strategies for birds exposed to extreme conditions and the conservation of landscapes with thermally buffered microsites used by birds during extremely hot weather.

Digestive flexibility in sparrow-weavers

Mpho Malematja began her MSc research during 2017 investigating phenotypic flexibility of digestive processes in White-browed Sparrow-weavers in response to diets of varying nutritional content. She will also investigate the physiological mechanisms underlying this digestive flexibility, by quantifying modulation of body mass, gut morphology and dietary enzyme activity. She captured and transported 45 sparrow-weavers from the Kalahari Desert to U. Pretoria SAPRF. During May to September

MSc student Mpho Malematja and Bill Karasov with a captive colony of White-browed Sparrow-weavers in one of the rooms of the new University of Pretoria Small Animal Physiological Research Facility (Photo: Andrew McKechnie).

2017, she collected data relating to body mass variation in birds maintained on various diets, as well as data on digestive system morphology following acclimation to various diet regimes. This project is co-supervised by Prof. Bill Karasov of the University of Wisconsin-Madison, who spent part of 2017 at U. Pretoria as a Visiting Professor.

Highlights:

- PhD student Tanja van de Ven graduated with her research on the link between temperature and reproductive outcomes in Southern Yellow-billed Hornbills.
- CB MSc student Ryan Olinger graduated with his thesis on the effects of temperature on foraging and parental decision-making in Fork-tailed Drongos.
- Krista Oswald, Nicholas Pattinson and Jerry Mokgatla Molepo graduated with their MSc degrees during 2017 at NMU.
- PhD student Ryan O'Connor submitted his PhD thesis in late 2017.
- New PhD student Nick Pattinson registered at UCT under the supervision of Susie Cunningham and Andrew McKechnie.
- New PhD student Celiwe Ngcamphalala started her project at U. Pretoria on phylogenetic variation in avian stress responses and the validation of non-invasive techniques for monitoring stress hormones in species that have been the focus of our behavioural studies.
- Andrew McKechnie was awarded a South African Research Chair in Conservation Physiology which secures funding for Hot Birds work for the next 15 years.
- Post-doc Margaux Rat was invited as a keynote speaker for the Zoological Foundation Week at the University of Uppsala, Sweden.
- The team published 18 papers in 15 journals: *Proceedings of the National Academy of Science, Austral Ecology, Bird Conservation International, Journal of Experimental Biology, Ostrich, African Journal of Ecology, Journal of Avian Biology, Journal for Ornithology, Journal of Biogeography, Journal of Comparative Physiology B, Ibis, Physiology & Behavior, Trends in Ecology & Evolution,* and *Proceedings of the Royal Society B*.

Key co-sponsors
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Dr Todd McWhorter (U. Adelaide)
Dr Margaux Rat (FIAO, UCT and U. Pretoria)
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Global change and urban birds

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

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

Understanding the consequences they face as a result of replacing their natural diet with this "junk-food" is one of the aims of our research on the campus starlings. A second aim is to investigate how they cope with the lack of food on campus over weekends and holidays. Finally, we are interested in how heat stress, promoted both by the urban "heat island" effect in an already warm climate, and ongoing climate warming, interacts with urbanisation to affect the birds.

Through intensive trapping efforts during 2017, we now have a core population of >130 individually colour-ringed starlings on campus. This has allowed us to identify that the campus starling community includes both breeding residents and a large "floating" population whose presence fluctuates with time of day. "Floater" birds ringed on campus also use areas in Rondebosch and Observatory, and gather in large numbers on parts of campus in the early evenings, for reasons which currently remain mysterious. Colour-ringing has also allowed us to monitor breeding pairs and their productivity; and to assess whether the ratio of anthropogenic natural food fed to chicks matches that of the adult diet. During ringing, we collect blood samples and morphometrics from each adult. We also ringed nestlings from first broods in 2017 with a red ring with white lettering for unique ID, and blood sampled these birds too. We intend to use these samples to assess the physiological impacts of an anthropogenic diet rich in junk food during 2018. This laboratory-based component of the project is being carried out in collaboration with Lund University, Sweden, as part of a bilateral project funded by the NRF and STINT (Swedish Foundation for International Cooperation in Research and Higher Education).

Activities in 2017

- In early 2017, we began trapping and colour-ringing of adult birds within the Upper Campus population. By the end of the year, we had managed to ring 132 individuals. During the breeding season we monitored nearly 30 nests and ringed 29 nestlings.
- Through a prolonged process of habituation, we have trained several birds to jump onto a scale and "weigh themselves", allowing us to obtain daily mass gain data. We are now working on correlating these data against climate variables and anthropogenic activity on campus.
- To date we have obtained over 1 000 mass measurements from 56 individuals and several unringed partners of these ringed birds.
- We established a Facebook page and a WhatsApp group to allow the UCT community to engage with the project and report resightings of colour-ringed birds. This has been incredibly successful, generating almost 1 700 resightings.

- We involved members of the UCT community in volunteer work ranging from monitoring nests to assisting with climbing for nestling ringing (with the help of the UCT Mountain and Ski Club).
- Miqkayla Stofberg's BSc (Hons) project found dietary changes on weekends and weekdays in non-breeding birds, with a near-significant knock-on effect on mass gain but surprisingly few implications for daily time-activity budgets. Miqkayla will register for a MSc in 2018 to investigate the effect of interactions between climate warming and urbanisation on the Red-winged Starlings.
- Sarah Catto (MSc CB) completed her data collection from the 2017 breeding season. Her data suggests that the effects of fluctuations in anthropogenic food supply may be stronger in birds under the additional pressure of provisioning nestlings.

Highlights:

- We received funding from the NRF and STINT for a three-year joint South Africa-Sweden Research Collaboration focusing on urban avian ecology (Swedish PI: Assoc. Prof. Caroline Isaksson, Lund University). The kick-off seminar was held in Pretoria in February 2017.
- We organised a workshop on the use of biomarkers in ecophysiology with our collaborators from Lund University before the European Ornithologists Union conference held in Finland. We secured travel awards for Miqkayla and Sarah to attend this workshop.

Impact of the project

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

Resident pair, male YM GP and unringed female, bred high on the east-facing wall of the Computer Science Building in late 2017. Here YM GP stands on a top pan scale in return for a small raisin reward (Photo: Callan Cohen).

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

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

Students: Ann-Kathrin Ziegler (PhD, Lund); Johan Jensen (MSc, Lund); Sarah Catto (CB MSc, UCT); Miqkayla Stofberg (BSc Hons, UCT).

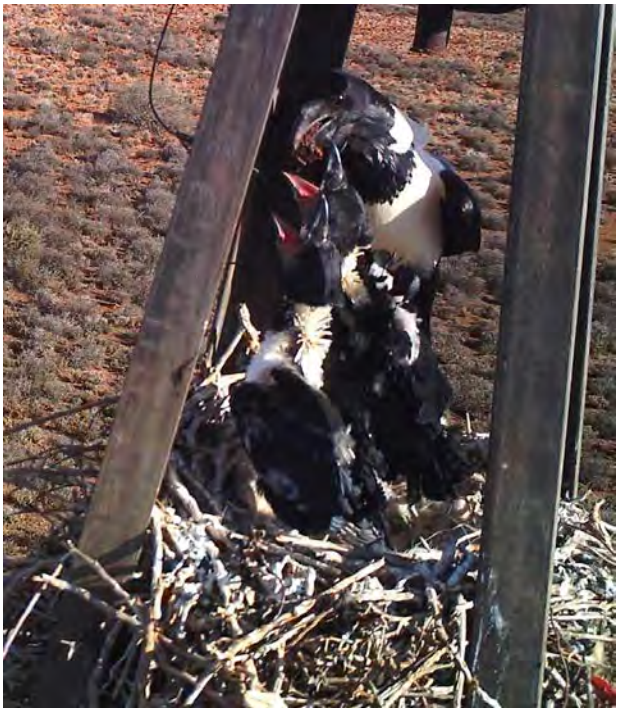
Research Assistants: Dane Paijmans, Jessleena Suri.

Volunteers: Adam Begg, Laura Figenschou, Tsilavo Razafimanantsoa, UCT Mountain and Ski Club, Olivia Venter, Vince Ward, 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 kill. 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, now termed a 'native invader' species, and tries 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, emphasizing 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 research has focused on quantifying predation on tortoises and avian nest predation. Our current research builds on other research conducted at the Fitz, which suggested that crows may benefit from the road kills. We are exploring whether nesting densities or breeding demography differ depending on proximity to roads of different types (tar or gravel) and their associated road kills. Other research aims to improve our basic ecological understanding of the species.



As it was not possible to identify prey items brought to the nests from camera trap photographs, this has not proved to be a useful method to quantify Pied Crow predation rates of tortoises (Camera trap photo: Rona van der Merwe).

Our research is currently focussed in the Hantam Karoo (Succulent Karoo). Within our study area we have crows nesting adjacent to tar roads and to gravel roads and we are examining the numbers of road kills found on these different roads, as well as monitoring the breeding crows that nest nearby. Additionally, we are seeking to understand the species' home ranges and ranging behaviours both inside and outside of breeding seasons by using GPS tracking devices.

Activities in 2017

- Rona van der Merwe started her MSc dissertation on Pied Crow ecology in the Karoo.
- Rona monitored 14 nests (six on gravel roads, eight on tar roads), and documented road kills from over 2 000 km of road transects.
- Two active nests had 41 tortoise carapaces on the ground below the nests. Rona set up a camera trap at one of these nests, which revealed that Pied Crows do not take tortoises to the nest, but rather prepare them nearby and take the meat to the nestlings.

In 2017 we attached the first ever GPS transmitter to a Pied Crow. This tag is working well and we have received several hundred fixes for this bird revealing insights into the movements of this species. Several more tags will be deployed in 2018 (Photo: Rona van der Merwe).

This is important because it means that checking of the areas around nests for tortoise remains might significantly underestimate the numbers of small tortoises killed by Pied Crows.

Highlights:

- Carles Durà completed his CB MSc project entitled "Understanding predation of tortoises by nesting Pied Crows (*Corvus albus*) in western South Africa". The thesis is currently being prepared for publication.
- Rona successfully captured one Pied Crow and fitted a GPS tracker to the bird – this is the first Pied Crow to ever be tracked.
- A 2015 review paper on the impact of corvids on other bird species by CB MSc student Chrissie Madden and Arjun Amar was the most highly cited paper from the journal *Ibis* in 2017.
- Research associates Grant Joseph and Colleen Seymour had an article published in early 2017 on the influence of road kill in explaining Pied Crow population increases (Joseph *et al*. 2017. *Biological Conservation*).

Impact of the project

This research aims to build our understanding of whether the increase in Pied Crows in certain regions of South Africa represents a conservation problem, and if so, what management actions might be most effective to deal with these concerns.

Key co-sponsors
DST-NRF CoE grant, Francois van der Merwe.

Research team
Dr Arjun Amar (FIAO, UCT)
Dr Susie Cunningham (FIAO, UCT)
Dr Robert Thomson (FIAO, UCT)
Dr Thomas Flower (FIAO, UCT and Simon Fraser University)
Dr Grant Joseph (FIAO, UCT and University of Venda)
Dr Colleen Seymour (FIAO, UCT and SANBI)

Students: Rona van der Merwe (MSc, UCT); Carles Durà (CB MSc, UCT).

Understanding urban raptor populations

Urban development is increasing across the globe and poses a major threat to biodiversity, which is often relatively depauperate in human-modified landscapes. In fact, next to climate change, the United Nations consider urbanisation the biggest environmental challenge to maintain biodiversity of our time. More people live in urban than in rural areas globally, and the trend towards urbanisation is faster in Africa and Asia than in any other regions of the world.

The Cape Peninsula is located on the south-western tip of the African continent, where climate change is predicted to be particularly rapid and severe. In this project we focus on the responses of raptors to increasing urbanisation under climate change. On the Cape Peninsula, urban breeding Peregrine Falcons *Falco peregrinus* and Black Sparrowhawks *Accipiter melanoleucus* have been monitored over 30 and 18 years, respectively. During this time, the populations of both species within the study area have increased markedly. We use these two long-term data sets on individually marked birds to investigate the effects of urban-living and weather on breeding phenology, reproductive performance, survival and population trends.

Beside habitat loss and fragmentation, wildlife in urban areas might also be negatively affected by altered bio-geochemical cycles and the introduction of novel urban stressors such as light, noise and chemical pollutants. Urban-exploiting or adaptable species that are able to make use of abundant resources in the short-term, might thus still suffer from other hidden costs of urban living which could undermine their long-term health and persistence in an urban environment. We use the Black Sparrowhawk study system and a biomarker approach to investigate such possible health impacts. The species seemingly thrives in the city, taking advantage of the availability of nesting trees in alien *Eucalyptus* and pine plantations and the high prey abundance of pigeons and doves. Taking small blood samples from adults and their offspring, we have quantified eco-physiological parameters such as immune assays, oxidative stress and dietary antioxidants. The eco-physiological component of this research has been carried out in collaboration with Lund University, Sweden, as part of a bilateral project funded by the NRF and STINT which will run between 2017-2020.

Black Sparrowhawk nestlings, approximately 5 and 11 days old photographed while a nest camera was being installed. The disturbance to the nest was less than 20 minutes and the female returned immediately after we left the site to brood her offspring (Photo: Shane McPherson).

Activities in 2017:

- In 2017, 66 Black Sparrowhawk chicks fledged from 36 territories. This is the largest number of fledglings since the beginning of the project in 2000.
- Sanjo Rose completed her BSc Honours project investigating breeding phenology, performance and colour morph distribution along an urban-rural gradient. Her thesis resulted in papers published in a special issue on "Behavioural and Ecological Consequences of Urban Life in Birds" in *Frontiers in Ecology and Evolution*, and another in the *Journal of Raptor Research.*
- Jessleena Suri published a paper from her Conservation Biology Master's thesis in *Ibis* on how urban prey abundance might buffer Black Sparrowhawks from potential negative health impacts of urbanisation.

A resighting of a Black Sparrowhawk male, ringed in 2011, on a Speckled Pigeon *Columba guinea* in Silvermine Village, near Noordhoek (Photo: Dave Black).

- Julia van Velden published a paper from her 2013 Honours project on the impact of skin burrowing mites on Black Sparrowhawk breeding performance in *Auk.*
- PhD student Carina Nebel visited Lund University in November to conduct the laboratory work necessary for the biomarker approach.
- We presented our research at the European Ornithologists' Union (EOU) conference in Turku, Finland, where we had the largest representation of South Africans to date at a European ornithological conference (funded through the NRF-STINT grant), and at the annual conference of the Birds of Prey Programme of the Endangered Wildlife Trust (EWT) at Witsand, Northern Cape.

Highlights:

- Together with Assoc. Prof. Caroline Isaksson, we received funding for a three-year joint South Africa-Sweden Research Collaboration focusing on urban avian ecology from the NRF and STINT.
- The kick-off seminar was held in Pretoria in February 2017 and a workshop on the use of biomarkers in ecophysiology was held before the EOU conference in Finland. Three PhD candidates from the raptor group attended who will apply the biomarker approach in their research, Carina Nebel and Edmund Rodseth from the Black Sparrowhawk project, and Christiaan Brink from the Vulture Conservation Project.

Impact of the project

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

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

Research team
Dr Arjun Amar (FIAO, UCT)
Dr Petra Sumasgutner (FIAO, UCT)
Dr Res Altwegg (SEEC, UCT)
Dr Andrew Jenkins (ADU, UCT)

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

Students: Carina Nebel (PhD, UCT); Jessleena Suri (CB MSc, UCT), Sanjo Rose (BSc Hons, UCT).

Research Assistant: Dr Shane MacPherson.

Balancing biodiversity and agriculture

Modern agriculture has revolutionised the planet's capacity to support humans, yet has simultaneously had a greater negative impact on biodiversity than any other human activity. Balancing the demand for food with the conservation of biodiversity is one of the most pressing issues of our time. While these concerns are relevant globally, there is an urgent need to conduct research of this nature in the developing world, characterised by high population growth rates and rapid agricultural development. This project focuses on providing the evidence to underpin better planning of production landscapes to offset the negative effects of agriculture on biodiversity in southern Africa. Post-doc Chevonne Reynolds is tackling this question in collaboration with Claire Spottiswoode, Res Altwegg of the Statistics in Ecology, Environment and Conservation group in the Department of Statistical Sciences, and Andrew Balmford of the University of Cambridge.

Is a land-sharing or a land-sparing strategy best for conserving southern African birds? These two strategies represent alternatives whereby conservation and production are integrated in space ("land-sharing") or separated in space ("land-sparing"). Advocates of land-sparing suggest that although land-sharing is beneficial within farmland, if it reduces yield then a larger area must be farmed to meet any given production target. However, the merits of each strategy are still hotly debated, in part because this question is typically addressed by short-term field studies that ignore processes relevant to biodiversity occurring at larger scales.

Making use of the remarkable South African Bird Atlas Project 2 (SABAP2) dataset, Chevonne is assessing how agricultural land-use patterns affect bird populations, and ultimately which strategy is best suited to the conservation of southern Africa's bird diversity. Combining the SABAP2 data with fine-scale data on agricultural land-use, Chevonne has investigated how the amount and configuration of farmland within each pentad (~ 9 x 7 km) affects the relative population density of bird species using occupancy models. She conducted the analysis across three separate biomes in South Africa to determine whether bird populations respond in a consistent way across regions and therefore whether results can be extrapolated to other landscapes. Her fascinating findings suggest that different strategies prevail based on the structure of the native vegetation and the type of agricultural product that is farmed. Within grasslands for example, a greater proportion of the bird community benefits from land-sharing farming practices, while in contrast bird communities of coastal forest rely on land-sparing and the preservation of large patches of native vegetation. Remarkably, agricultural land conversation is not all doom and gloom, and several endemic species, particularly in the fynbos, appear to be reliant on agricultural land. Here, it is possible that agricultural production is mimicking ecological processes once carried out by megafauna that are now largely extinct from the region. This research highlights once again that successful conservation approaches are

Blue Cranes are one bird species that benefit from agricultural production in the Fynbos biome, but prefer a land-sparing approach in the Grassland biome (Photo: Davide Gaglio).

context dependent and that one-size-fits-all conservation strategies are not able to address the challenge of protecting biodiversity in agricultural landscapes.

Chevonne is also collaborating with researchers at the University of Florida and the University of Swaziland to investigate how landscape heterogeneity in agricultural mosaics affects biodiversity. A key feature of the developing world is that agriculture is typically interspersed among other land-uses, creating heterogeneous landscapes. While there is evidence that landscape heterogeneity positively influences biodiversity, the application of this hypothesis is hindered by a lack of understanding of which components of landscape heterogeneity drive these effects, and at what spatial scale(s). We also need to know whether diverse taxonomic groups are similarly affected before we can apply this hypothesis as a general conservation strategy in agricultural mosaics. Chevonne led a team of international students to collect data on several taxonomic groups in the savanna-sugarcane mosaics of north-eastern Swaziland in June and July 2017.

The theme for the second year of the project was connectivity, and working at the interface between savanna and agriculture, both intensive sugarcane farming and less intensive subsistence farming, they tested how birds, dung beetles, rodents and even trees could move between the land-use types. As expected the results varied among taxonomic groups, however one key finding relating to birds was that smaller species with short wings are more limited in their dispersal ability. These findings suggest that certain species may become isolated in savanna fragments as agriculture expands, limiting connectivity across populations.

Activities in 2017

- Chevonne Reynolds continued as a Post-doctoral researcher on the project. She completed the initial analyses and started preparing manuscripts for publication.

Highlights

- Continued collaboration between the Fitz and the Statistics in Ecology, Environment and Conservation (SEEC) research group.
- Teaching and training of the University of Swaziland and University of Florida students on field and research techniques.
- Two papers resulting from Chevonne's team's research in Swaziland were published in the journals *Landscape Ecology* and *Insect Conservation and Diversity*. An additional paper is in revision at *Biodiversity and Conservation* and three others are in preparation.
- Chevonne was appointed as a lecturer at the University of the Witwatersrand from January 2018, but will remain a member of the Fitz Centre of Excellence.

Impact of the project

Using ecological and life-history traits to explore species responses to agriculture we hope to develop a generalizable framework to help conservation planners, farmers and policy makers improve management for biodiversity in production landscapes.

Chevonne and students mist-netting birds on a misty morning in north-eastern Swaziland (Photo: Davide Gaglio).

Key co-sponsors

DST-NRF CoE grant; National Science Foundation (USA).

Research team

Prof. Claire Spottiswoode (FIAO, UCT and U. Cambridge)
Dr Chevonne Reyolds (FIAO, UCT)
Prof. Res Altwegg (SEEC, UCT)
Prof. Andrew Balmford (U. Cambridge)
Prof. Bob McCleery (U. Florida)
Prof. Ara Monadjem (U. Swaziland)

Plastics in the environment

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

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

Activities in 2017

- From December 2016 to March 2017, Peter took part in the Antarctic Circumnavigation Expedition (ACE), leading a project designed to assess the abundance and distribution of microplastics in the Southern Ocean. Most samples were processed in 2017, and a paper on the preliminary findings presented at the 6th International Marine Debris Conference in San Diego in March 2018.
- Meso- and microplastic samples were collected at 16 Mile Beach in the West Coast National Park as part of a study to assess the relative importance of mass and abundance as currencies for reporting plastic debris. This work also was presented at the 6th International Marine Debris Conference.
- Monthly clean-ups of intertidal litter at Muizenberg corner run in conjunction with The Beach Collective continued throughout 2017. The November 2017 clean-up saw a massive influx of sea-bed plastics – in order of magnitude more litter than recorded in any previous clean-up – providing further impetus to assess the abundance and distribution of sea-bed plastics in South Africa. Examination of more than 300 images of the False Bay sea bed collected by Lauren de Vos as part of her PhD with Prof. Colin Attwood yielded no visible litter items.
- Vonica Perold ran a project on sampling plastics at sea during the SEAmester at Sea cruise in July, obtaining excellent reviews from the student trainees on the cruise while also gathering valuable information on meso- and macro-plastic abundance on a transect west of Cape Town into the South Atlantic gyre. We also collected a valuable data set on plastics in the western Indian Ocean off Mozambique and Tanzania during the IOE II cruise of the *SA Agulhas II* in October-November.
- Peter Ryan gave several talks on plastic pollution to community groups, and other interested parties, including a well-attended talk hosted by Nedbank for WWF-SA and BirdLife SA in October, and was an invited speaker at the Volvo Ocean Summit, held in Cape Town in December.
- Also in December, given the strong focus of the UN Environmental Assembly in Nairobi on curbing plastic pollution, Peter was invited to be part of the French delegation to this meeting. He participated in a panel discussion as part of the formal proceedings, and gave a talk on microfibres in the marine environment in a fringe event on plastics in marine ecosystems.

The mostly spring low tide cleanups at Muizenberg corner typically collect 200-600 litter items, but the November 2017 clean-up netted nearly 9 000 items, most of which were more dense than sea water and had been at sea for some time. Mari-San Jacobs, Eleanor Weideman and Vonica Perold had the task of sorting and counting the litter (Photo: Peter Ryan).

Highlights

- Two papers were published in 2017: one in *Marine Pollution Bulletin* on microplastic ingested by and adhering to the feathers of waterfowl, arising from Chevonne Reynold's PhD, and one in *Scientific Reports* challenging a high-profile 2017 paper by Savoca *et al*. claiming that scent attraction contributes to plastic ingestion in seabirds.
- A paper summarising 20 years of meso-plastic sampling around the South African coast was accepted by *Environmental Pollution*, and published in early 2018.
- The collaboration with Dr Stefano Aliani's group at CNR-ISMAR (the Italian Research Council's Institute of Marine Sciences) in La Spezia was bolstered by ACE funds being used to help purchase a micro-FTIR system to identify microplastic fibres and fragments. ACE funds will also support PhD student Giuseppe Suaria after he completes his thesis.
- Recent UCT honours graduate and long-standing field assistant on this project, Eleanor Weideman, was recruited to undertake an MSc on freshwater plastic pollution in 2018.
- Peter Ryan was invited to attend the UN Environmental Assembly in Nairobi in November 2017 and was appointed a full member of the Scientific Committee for the Ocean (SCOR) working group on floating debris (FLOTSAM). He is a member of the UN's GESAMP Working Group 40 which is now in its third phase, and tasked with harmonising methods for monitoring and assessment of marine plastics and microplastics.

Key co-sponsors
Plastics SA, ACE Foundation.

Research team
Prof. Peter Ryan (FIAO, UCT)
Assoc. Prof. Coleen Moloney (MaRe, UCT)
Aaniyah Omardien (The Beach Collective)
Prof. Hideshige Takada (Tokyo)
Dr Stefano Aliani (CNR-ISMAR)
Guiseppe Suaria (CNR-ISMAR)

Field assistants : Vonica Perold, Mari San-Jacobs, Lucy Smythe, Eleanor Weideman.

Conservation Biology Masters programme 2017

The 2017 MSc CB class in the lab during the Conservation Genetics module, led by Dr Jacqui Bishop. (Photo: Oyena Masiko)

The 2017 intake of CB students comprised 13 students from Botswana, Finland, the Republic of Congo – Brazzaville, South Africa, USA, UK, and Zimbabwe. They were a strong cohort academically, with no fewer than nine students achieving distinctions for the coursework component! At the time of writing, the students are hard at work finalising their theses for submission by 19 February 2018.

The 2018 cohort of students arrived mid-January 2018. Students from six countries including South Africa were offered and accepted places in the 2018/19 class in late 2017. Due to visa and personal issues three international students pulled out immediately prior to the start of the course in January 2018, resulting in the loss of three of these six nationalities from the class mix. We were able to replace some of these losses with local students and are happy to welcome a cohort of 12 students for 2018, from three nationalities: South Africa, Austria and the USA. This is the first year for some time that we lack students from Africa outside of South Africa in the class, despite two initial acceptances – both due to visa-related issues. While this is a sad loss, we still have a broad diversity of backgrounds, experience and expertise in the class and we look forward to a stimulating year.

Course structure and teachers

The course continues to be taught by a wide range of module leaders from both within and outside UCT. In 2017, module leaders included David Cumming (Big Picture & Philosophy of Science); Wendy Foden (Conservation Leadership); Susie Cunningham (Biodiversity Basics); Robert Thomson and Timm Hoffman (Community Ecology); Arjun Amar (Statistical Analyses and Project Planning); Sebataolo Rahlao and John Hoffman (Invasion Ecology); Colin Attwood (Marine Conservation); Justin O'Riain, Guy Balme and Ross Wanless (Conservation in Practice); Kristi Maciejewski and Chevonne Reynolds (Landscape Ecology & GIS); Cecile Reed (Freshwater Conservation); Jane Turpie (Resource Economics); Gladman Thondhlana (Conservation and Society); Claire Spottiswoode (Project Planning); Peter Ryan (Demography and PVA); Lindsey Gilson (Climate Change); and Jacqui Bishop (Conservation Genetics). In addition, many other people continue to contribute through guest lectures, field trips and discussions. This diversity

of perspectives adds greatly to the value of the course

Challenges and opportunities

A module on Restoration Ecology is still missing from the course – we continue to look for opportunities to reinstate this module. In addition, Home Affairs regulations continue to cause problems for international students, mostly related to extremely long delays in obtaining study visas. Related to this, we were unable to retain any of the African students from outside of South Africa who were offered and accepted places on the course for 2018. We are also currently concerned about the as-yet-unknown impact of Cape Town's water crisis on our ability to run the course in 2018. We hope many of these issues will resolve themselves with time and indeed that our graduates will be equipped to help in the resolution of some (e.g. those related to natural resource management and availability). On the positive side, we are very excited to have attracted the input of Dalton Gibbs from the City of Cape Town, who will be running a new module on Urban Ecology & Conservation in 2018. Given that urbanisation is now one of the major threats to biodiversity internationally, we think that the addition of this module is timely and we are excited to welcome Dalton to the team. Overall, we remain committed to offering a balanced programme exploring the social and ecological aspects of Conservation Biology, and to producing world class graduates in this field.

Highlight

Wesley Gush's (2016 class) research on the Rudd's Lark *Heteromirafra ruddii* provided the crucial evidence underpinning this species's uplisting in 2017 to Globally Endangered by BirdLife International; his paper is currently under review.

MSc Conservation Biology projects 2017

Button, Rio: Remotely operated vehicle exploring icthyofauna association with habitat from shore-shelf, in an endemism hotspot in South Africa (Supervisors: Sven Kerwath, Denham Parker)

Catto, Sarah: Fluctuating human activity and associated anthropogenic food availability affect behaviour and parental care of Red-winged Starlings. (Supervisors: Susan Cunningham, Arjun Amar, Petra Sumasgutner)

Davis, Sydney: The movement and landscape use of Blue Cranes in the Western Cape. (Supervisors: Peter Ryan, Tanya Smith)

Dubay, Shannon: Behavioural and physiological responses of chacma baboons *(Papio ursinus)* to wildfire in the Cape Peninsula of South Africa. (Supervisors: Justin O'Riain, Larissa Swedell, Steffen Foerster, Matthew Lewis)

Hyvärinen, Olli: Long-term vegetation change before and after converting from livestock farming to game ranching in Asante Sana Game Reserve, South Africa. (Supervisors: Timm Hoffman, Chevonne Reynolds)

Kelly, Caitlin: Investigating the hidden costs of livestock guarding dogs and the diet of a sympatric predator in Namaqualand, South Africa. (Supervisors: Justin O'Riain, Kristine Teichman, Marine Drouilly)

Leepile, Leungo: Changes in nesting numbers and breeding success of African White-backed Vultures in northern Botswana. (Supervisors: Arjun Amar, Glyn Maude)

Lindberg, Colleen: Ecological impacts of invasive mussels *(Mytilus galloprovincialis)* colonising the canopy of kelp forests in False Bay, South Africa. (Supervisors: Charles Griffiths, Robert Anderson)

Masiko, Oyena: Are Cape Cormorants *(Phalacrocorax capensis)* losing the competition? Dietary overlap with commercial fisheries. (Supervisors: Azwianewi Makhado, Robert Crawford, Peter Ryan)

Mavinga, Franck: A camera trap assessment of factors influencing leopard *(Panthera pardus)* habitat use in the Nouabale-Ndoki National Park, Republic of Congo.. (Supervisors: Justin O'Riain, Gareth Mann, Thomas Breuer)

Mottram, Phoebe: Landscape utilisation by a reintroduced pack of African Wild Dogs (*Lycaon pictus*) in eastern Botswana.. (Supervisors: Justin O'Riain, Andrei Snyman, Gareth Mann)

Van Beuningen, David: Environmental predictors of *Carcharodon carcharias* presence at two popular beaches in False Bay, South Africa, using acoustic telemetry (Supervisors: Justin O'Riain, Alison Kock)

Zimunya, Tapiwa: The influence of vulture restaurants on breeding success and nestling body condition of Gyps vulture populations across southern Africa (Supervisors: Robert Thomson, Arjun Amar)

Niven Library

The Niven Library is the intellectual and emotional heart of the Fitz. It is making the transformation to the digital era, providing an ever increasing array of information – both publications and data – to users on the internet all over the world. Taking over the core functions of SAFRING from 2018 adds to its increasing digital footprint.

In 2015, the library embarked on a project to archive all Fitz data on an accessible, user-friendly database. However, the initial plan for digital data archiving instigated with the South African Environmental Observation Network (SAEON) has been superseded by a university-wide digital data repository to be established using Figshare. The Fitz will partenr with UCT Libraries to make use of this repository for its archiving requirements. The data will be structured to recognize data creators, such that data may be easily identified and acknowledged. This system also allows for the tracking of usage and impact of data. Testing of the Figshare repository system began in June 2017.

We continue to use the web-based information management system, Electronic Research Administration (eRA), to capture scientific publications for annual reporting to the Department of Higher Education for subsidy purposes. The system has been tweaked and updated during the course of the year, making the process of capturing publications somewhat more efficient.

Staff Development

Niven Librarian, Susan Mvungi, and her assistant, Phelisa Hans, attended UCT training courses on eRA during 2017. Susan has also taken over the task of entering the Fitz publications onto the eRA system. Phelisa is studying towards her degree in Library and Information Science with the University of the Western Cape.

UCT hosts several online courses as part of its Open Educational Resources and Massive Online Open Courses (MOOCs). Susan completed a five week online course on Research Data Management and Sharing (RDMS). The course covered various topics that encourage effective management and sharing of data.

In addition to the online course, Susan attended winter training courses/workshops with UCT Libraries: Bibliometrics training on Scopus and SciVal (26 July); Open Access Publishing, using Open Monograph Press and Open Journal Systems (1 August); and Systematic Reviews (10 August). She also attended a webinar hosted by UCT Library titled 'SciVal: Topic prominence in Science'.

SAFRING website

New Developments

Most of the South African Bird Ringing Unit (SAFRING) administration functions will be absorbed by the Fitz. The bird ringing scheme was initiated in 1948 with the main objective of establishing a database of southern African bird ringing effort and recoveries. The database is utilised by students, researchers and conservation biologists. The database provides details of bird movement and survival, and contains ringing and latest retrapping details of recaptured birds.

Collection Development

The Niven Library now contains digital copies of all Conservation Biology MSc theses, which They are available through an author and thesis link on the Niven Library catalogue.

Phelisa Hans has made good progress digitising theses and honours projects, and has continued to digitise the Richard Brooke reprint collection, which consists of 18th and 19th century articles and manuscripts which are not available on the catalogue.

Donations

The Niven Library received various donations of books, journals, review books, and artefacts

during the course of the year. In particular donations from Jansie Besaans, Elaine Cherrington, Tim Crowe, Richard Dean, Dalton Gibbs from the City of Cape Town's Transport and Urban Development Authority, Pat Lockhart, Michael Mills, Patrick Morant, Terry Oatley's collection of notes, letters and articles donated by his wife Margaret Oatley, Dieter Oschadleus, Dayo Osinubi, Peter Ryan, Claire Spottiswoode, Antje Steinfurth and Peter Steyn.

New Books section (Photo: Susan Mvungi)

New titles

The Niven Library purchased 22 books during 2017. A further three books were received for book review in *Ostrich*.

Book Sales

The annual book sale raised R 4 316.

Library Use

The Niven Library was used on 69 occasions for presentations, meetings and seminars during 2017, and was the main venue for the Fitz lunch-time seminars. The Library was photographed by UCT's Irma Stern Museum and Works of Art Collection., and the Library's egg collection was viewed by external UCT students on two occasions.

Susan Mvungi presented the annual MSc Conservation Biology information skills workshop during January 2017. Students toured the Niven Library and the main UCT Library, and were shown the difference between the Niven Library catalogue (Amlib) and the Main Library catalogue (Aleph). Students were also taught how to use referencing software to correctly reference articles.

Niven Library Stock Circulation

An increase in the use of journals is largely attributed to the 'Hot Birds Project', which investigates desert birds with wide-spread focus determining their responses to climate change and rising temperatures, and to the Animal Demography Unit (ADU) digitising project. There has been a decline in the use of audio-visual material and nest-record cards over the years. The use of books has also declined, possibly due to the increasing availability of ebooks. Overall, the Niven Library circulation has increased from previous years.

	2017	2016	2015
Monographs	151	218	230
Theses	16	16	12
Journals	425	304	161
Audio-visual	2	13	5
Nest Record cards	2	8	26
Total	596	559	434

Requests for Information

The Library received 2 528 requests for information in 2017, of which 462 pdfs were supplied by email to users nationally and internationally. Other uses of the Library were for the calculation of H-indices, citation information confirmation, URL links to articles, journal impact factors, UCT Libraries book location, Inter-library loans, nest record cards, UCT library loan renewals, and other general requests. Literature searches were done on request, compiled and emailed to users.

More than 60 national and international organisations requested information from the Niven Library during 2017. These requests came from far and wide, including from the Albatross Task Force, Australian Antarctic Division, BirdLife Botswana & Mozambique, LEGECE Brazil, British Trust for Ornithology (BTO), IRD Paris, Island Conservation Society Seychelles, National Museums Scotland, Natural History Museum Rotterdam, RSPB Library UK, Swansea University UK, Taipei Medical University and Wildlands Trust UK. Locally, requests came from the Antarctic Legacy of South Africa, BirdLife SA, Cape Nature, Department of Agriculture, Forestry and Fisheries, East London Museum, RENU-KAROO Veld Restoration cc, SANParks, Wits Bird Club, WWF-SA and the universities of Limpopo, NMU, Pretoria, Rhodes and UKZN.

Books published by Fitz staff and research associates during 2017.

Information sharing, collaboration and service rendering

With the third 5-year cycle of Centre of Excellence (CoE) support ending in 2019, the Fitz CoE was asked by the Department of Science and Technology to draft a vision document summarising the Centre's contribution nationally and internationally. This is an extract from that document.

Although the Fitztitute's primary activities are conducting research and training graduate students to become leading scientists, information sharing, collaboration and service rendering to civil society have contributed to research excellence at the Fitz CoE.

There is no doubt that the formation of the Fitz CoE in 2004, with its generous grant and cross-institutional partnerships, has greatly improved the quality and quantity of research outputs over the last 13 years. This was highlighted in May 2017 when UCT was listed as the joint third most important university in the world for ornithological research by the Center for World University Rankings.

The Fitz CoE is a network of researchers and students at five South African universities and a diverse array of research associates and collaborators throughout the world, who share the common vision of using birds to understand and mitigate the impacts of global change on natural systems. The Fitz team aims to develop a better understanding of the threats of global change in all its forms, and to devise practical and effective mitigation measures to minimize anthropogenic impacts.

Fitz staff and students also endeavour to make their research as broadly known and relevant as possible through information sharing. We develop research approaches with a broad range of collaborators, and work closely with policy makers and conservation practitioners across the public-private spectrum to enhance biodiversity conservation. Our ultimate goal is to improve human quality of life through human capital and information development to enable sustained management of ecosystem services and to create employment opportunities linked to the green and blue economies. Fitz students also go on to become leaders in biodiversity and conservation science within academia, conservation organisations, government and industry, in South Africa and across the world.

Information Brokerage

The Fitz provides access to a highly developed pool of knowledge and promotes knowledge sharing. It popularises the fields of ornithology and conservation biology, provides expert views on relevant matters for popular media, and contributes to books of a semi-technical nature. Fitz CoE members published 55 semi-popular articles in the public media, two books and five chapter contributions to semi-technical books during 2017. They also presented over 50 seminars and illustrated talks at numerous universities, bird clubs and membership-based societies, and participated on 76 membership fora and advisory services during 2017.

Relationships have been developed with various media partners, including TV, radio, newspapers and magazine publishing houses, both locally and abroad. The CoE has regular features in *African Birdlife, SANParks Times, Wild* magazine, and is increasing its exposure in *The Conversation*. Our research activities are promoted via social media through active Twitter (@Fitztitute) and Facebook pages. Various research projects also have their own vibrant social media presence. The Fitz website www.fitzpatrick.uct.ac.za offers information on research and related activities, and includes pdfs of more than 100 Fitz articles published in *Africa Birds & Birding* and *African Birdlife* since 1996. The Fitz also organizes a biennial ornithological conference, co-hosted with BirdLife South Africa, which attracts several hundred participants and includes a 'layman's lab' designed to increase the exposure of our research to a wider audience.

Networking:

The Fitz collaborates with a diverse array of institutions, groups and individuals to enhance national, regional, continental and international partnerships. The main objectives are to establish 1) collaborative associations with scientific peers and peer research groups, both

Four students from the University of Limpopo, Abigail Ramudzuli, Helga Chauke, Clementine Malatji and Thato Mashigo, visited the Fitz from 19 June to 6 July 2017 to gain exposure to the broad ornithological research programmes at the Institute (Photo: Peter Ryan).

locally and abroad, 2) partnerships with relevant government departments, conservation organisations and NGOs, and 3) strong relationships with businesses that have direct or indirect interests in the fields of ornithology and conservation biology. To achieve this, the Fitz promotes networking between team-members at other institutions that collaborate with the Fitz. Primary collaboration continues with the University of Pretoria, Nelson Mandela University, the University of the Witwatersrand, Rhodes University, the University of Limpopo, the Tshwane University of Technology, the University of California, Berkeley, the University of Western Australia and the University of Cambridge. A diversity of collaborative working relationships with more than 100 scientific peers exists both nationally and internationally, who together engage with the Fitz to better understand and offer solutions which address the implications of global change.

Service rendering:

The Fitz provides information, policy and other services, including informed advice on biodiversity conservation measures to a wide range of governmental departments, conservation implementing agencies and other industry players (e.g. Plastics SA and the South African Deep Sea Trawling Industry Association). This advice is offered directly to policy makers in para-statals (SANBI, SANParks, CapeNature, Ezemvelo KwaZulu-Natal Wildlife) and government departments (e.g. drafting NEMBA regulations and permitting guidelines for the Department of Environmental Affairs (DEA), contributing to fishery management working groups for the Department of Agriculture, Forestry and Fisheries (DAFF), reviewing best-practice guidelines for managing the wind and solar energy industry for DEA, etc.). Service rendering is not confined to South Africa, with inputs being given to the UK (for Tristan da Cunha and Gough Island), international agreements (e.g. CCAMLR, CMS, ACAP and RFMOs), as well as collaboration with the Namibian Ministry of the Environment, the Botswana Department of Wildlife and National Parks, and the Marine Stewardship Council for regional fisheries. The Fitz also works with partner NGOs such as the BirdLife network (including BirdLife Botswana, South Africa, Zimbabwe), Conservation International, the Endangered Wildlife Trust (EWT), Fauna & Flora International, the IUCN, Nature Conservation Corporation, the Royal Society for the Protection

A group of second year students sample buried plastic pollution in a South African beach (Photo: Peter Ryan).

of Birds, the World Conservation Society (WCS) and the World Parrot Trust to effect changes in the biodiversity conservation arena and related industries.

Alignment with national strategies:

The broad framework within which the Fitz operates is set by the White Paper on Science & Technology (1996), as elaborated in the South African National Research and Development Strategy (2002). The mission and thus fundamental activities of the CoE address the primary aim of the White Paper "to enjoy an improved and sustainable quality of life". In 2007, the DST adopted the 10-year innovation plan to transform South Africa to a knowledge-based economy. The Fitz acts as a cross-cutting enabler to feed scientifically trained human capital into addressing four of the five grand challenges of the DST Innovation towards a Knowledge-Based Economy (2008-2018); Global change science, Strengthening the bio-economy, Energy security, and Human and social dynamics of indigenous knowledge and biodiversity heritage. The Fitz is also directly relevant to two of the four Geographic Advantage Areas identified by the NRF's Strategy 2020: Biodiversity and Antarctic Research.

There is also overlap with the South African National Biodiversity Institute (SANBI) mandate, as set out in the National Environmental Management Biodiversity Act (NEMBA) No. 10 of 2004, to understand and maintain biodiversity for the benefit and enjoyment of all South Africans. The Fitz also supports the South African Earth Observation Network (SAEON) mandate, according to the Science and Technology White Paper of 1995 and the National Research and Development Strategy of 2003, in the context of the National Global Change Research Plan. Among the most important long-term data sets maintained by the Fitz are demographic studies of key indicator populations of birds, including various raptors, seabirds, ground hornbills and passerine birds. Our research contributes to Long-term Ecological Research (LTER) sites in Algoa Bay and the proposed LTER site at Marion Island.

From December 2016 to March 2017, Peter Ryan was one of only two project leaders to participate in all three legs of the Antarctic Circumnavigation Expedition (ACE) on the Russian icebreaker *Akademik Tryoshnikov*. This research cruise, organized by the Swiss Polar Research Institute, supported 22 research projects. Peter was involved in projects on microplastic pollution of the Southern Ocean, and

estimating bird populations at seldom visited breeding sites. Peter facilitated the donation of the expedition's three helicopters, jet fuel and a cash donation to DEA for use in attempts to eradicate introduced House Mice *Mus musculus* from oceanic islands. This donation stimulated the SA government to prepare for an eradication attempt on Marion Island in 2020, following the eradication planned for Gough Island by the UK in 2019.

Meeting South Africa's obligations to international treaties:

The Fitz is a key partner in helping government departments to meet national obligations to several international treaties. It is the main contributor of South African data to the Agreement on the Conservation of Albatrosses and Petrels (ACAP), as well as assisting with South African contributions to Regional Fishery Management Organisations (RFMOs) such as the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC) and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). The Fitz assists DEA with reporting to the Committee for the Conservation of Antarctic Marine Living Resources (CCAMLR) under the Antarctic Treaty. In the case of ACAP, Fitz involvement extends to assisting with implementation of mitigation measures to reduce human impacts on affected species, such as planning to eradicate introduced House Mice from Marion Island.

The Fitz also provides inputs to treaties under the Bonn Convention on the Conservation of Migratory Species, such as the African-Eurasian Migratory Waterbirds (AEWA) and the recently ratified CMS Multi-species Action Plan to conserve African-Eurasian Vultures. At the highest level, the Fitz contributes to South Africa's obligations under the Convention on Biological Diversity (CBD), through the National Biodiversity Strategy and Action Plan (NBSAP), and the United Nations Framework Convention on Climate Change (UNFCCC).

Peter Ryan and John Kelly, head of the RSPB initiative to eradicate mice from Gough Island, celebrate the donation of three helicopters to the South African Department of Environmental Affairs (Photo: Guy Preston).

Scientific publications 2017

Names in **bold** are members of the Fitztitute or the Centre of Excellence. IF = Impact Factor.

Final Journal Published Papers

Albright, T.P., Mutiibwa, D., Gerson, A.R., Smith, E.K., Talbot, W.A., O'Neil, J.J., **McKechnie, A.E.** and Wolf, B.O. 2017. Mapping evaporative water loss in desert passerines reveals an expanding threat of lethal dehydration. *Proceedings of the National Academy of Science* 114: 2283-2288. (IF 9.423)

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Asefa, A., Davies, A.B., **McKechnie, A.E.**, Kinahan, A.A. and van Rensburg, B.J. 2017. Effects of anthropogenic disturbance on bird diversity in Ethiopian montane forests. *Condor* 119: 416-430. (IF 1.427)

Atkins, A., **Redpath, S.M.**, **Little, R.M.** and **Amar, A.** 2017. Experimentally manipulating the landscape of fear to manage problem animals. *Journal of Wildlife Management* 81: 610-616. (IF 1.725)

Ball, A.D., van Dijk, R.E., **Lloyd, P.**, Pogány, Á., Dawson, D.A., Dorus, S., **Bowie, R.C.K.**, Burke, T. and Székely, T. 2017. Levels of extra-pair paternity are associated with parental care in penduline tits (*Remizidae*). *Ibis* 159: 449-455. (IF 1.804)

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Benítez-López, A., Viñuela, J., **Mougeot, F.** and García, J.T. 2017. A multi-scale approach for identifying conservation needs of two threatened sympatric steppe birds. *Biodiversity and Conservation* 26: 63-83. (IF 2.258)

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Carpenter-Kling, T., **Dickens, J.** and **Pistorius, P.A.** 2017. First record of an Adélie penguin at sub-Antarctic Marion island. *Marine Biodiversity Records* 10: 13. (No IF)

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Dilley, B.J., **Davies, D.**, Schramm, M., Connan, M. and **Ryan, P.G.** 2017. The distribution and abundance of Blue Petrels (*Halobaena caerulea*) breeding at subantarctic Marion Island. *Emu* 117: 222-232. (IF 1.035)

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