

Final Evaluation Report

Your Details	
Full Name	Carrie Hickman
Project Title	The effects of high temperatures on nestling growth & physiology in the Southern Ground-Hornbill
Application ID	33007-1
Date of this Report	25/05/2022

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Measure nestling growth rates.				Measured seven nestlings this breeding season, bringing us to a total of 21 nestlings for this research so far. Five nestlings were unfortunately predated early in the season. We need to obtain a larger sample size which we hope to do over the next two seasons.
Obtain samples to measure physiological effects (measured as telomere length).				We successfully obtained samples from seven nestlings this season and ideally, we would obtain more for a more statistically robust study on physiological effects. Samples were sent to Strasbourg, France where they will be analysed.
Installing and testing new artificial nests temperatures.				We installed three new artificial nests, which were found by the birds and lined with nesting material, but they did not breed this season. We installed temperature loggers (iButtons) in 10 new artificial nests and temperatures were compared to external environmental temperatures and air temperatures. Data was shared with The Mabula Ground-Hornbill Project who will use these results to help improve future nests and they will also publish the results.
Measure ground-hornbill adults' weight and body condition.				We made a prototype scale to be installed at nest sites but have been unable to execute this successfully in the field. It will require more time and work to achieve this objective.
Disseminate findings to local communities & field rangers as well the scientific community.				We conducted several educational talks to local communities and guides. Local guides and rangers also assisted us in the field with installing and checking nests, where we discussed the conservation interventions and threats that ground-hornbills face. We published three popular articles in a local magazine. The project attended one in person

			conference, two online conferences, and four webinars/workshops where results were presented.
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2. Describe the three most important outcomes of your project.

- a) Awareness and support.** The project is growing an awareness of the threats the species face and how research can inform conservation practices. We have obtained an increase in the number of local rangers and guides who contribute to the project by assisting with nest installations and submitting sightings to us, which are valuable at identifying ground-hornbill numbers and movements in the area. We were able to share research finding at the Ground-hornbill Working Group annual meeting, which allows researchers and conservationists to collaborate on an international scale.
- b) Successful research methods.** Through The Rufford Foundation's support we have been able to purchase equipment and new technology that allowed us to carry out fieldwork effectively. We have successfully collected data on nestling growth and physiology. Our techniques in obtaining this data, weighing, measuring, and sampling chicks as well as using camera traps to assess provisioning rates, with minimal disturbance, has proven to be a very effective and successful method for this research. From the use of camera traps at nests we found that nest failures are largely due to predation from leopards and genets. This information is valuable in assessing the natural threats that the birds face, and nest predation seems to be occurring more than what we had previously believed. The scope of this research was recognised by the FitzPatrick Institute of African Ornithology, and a recent proposal to upgrade my research to a PhD study was successful.
- c) Artificial nests.** We installed three new artificial nests which were taken up almost immediately by groups who have not bred in years. Although they did not go on to lay it is still very positive and we hope they will breed in coming years. It is normal for birds to test the nest, lining it with leaves and for the female to sit in the nest before breeding which does not always occur every year for some groups. Testing the thermal properties of nests has identified what work needs to be done on future nest builds, such as using more natural and sustainable materials and ensuring that there is more air flow, allowing heat to dissipate from the nests more effectively. We also identified the importance of nest location, such as placing them under shadier tree canopies and being less conspicuous to predators. Although the use and uptake of these nests has been very successful since the project began in 2000, we have identified that the sub-lethal effects of increasing temperatures on nestlings should be considered and applied to future nest installations.



Nestlings being measured at one day old to 75 days old.



Camera trap footage of nestling fledging.



Camera trap footage of group member feeding chick in nest.



Camera trap footage recorded predation events

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

Weighing the adult birds at the nest proved to be difficult to execute. We were not able to install a working prototype scale in time, before the birds began breeding, so as not to disturb the birds by placing something new at the nest which could lead to them abandoning eggs. The scale proved to be tricky in a few ways; programming the scale to record and store weight data over time, ensuring that the load cells were attached in a way that was separate from other structures such as the nest to obtain accurate readings, building a level perch that the birds would use and that would obtain accurate readings from the load cells. In a captive setting this may be more attainable, but in the wild we try to use natural structures to not deter the birds from using the nest and we also need to ensure that any cabling and wiring to batteries is completely hidden and out of sight. Their curiosity and instinct to destroy objects means that we might lose expensive equipment or cause harm to the birds if we do not set this up correctly. We will continue to try to make prototypes, but this will take more time and experimentation before we get it right. We might consider trying and testing the scales in a captive setting where the birds will not be disturbed by human presence as we alter and adjust the scales over time.

Weather also proved to be difficult to navigate this past season. We had a lot of storms and rainfall during the early stages of breeding which meant that we couldn't always access nests. We do not check nests when it's raining because if we flush the female from the nest, we leave the eggs or young chicks exposed to the cold, which could be detrimental to their development and health. This meant that we struggled to get accurate predictions on hatching dates for some nests. This

resulted in missing or not being able to weigh some chicks at 1-day old. We can overcome this by accounting for these missed measurements in our statistical analyses. We also lost five chicks to predation, which means our sample size for the season was slightly lower than we hoped for. Reproductive rates for this species are low so we were aware of this being a potential implication. We will continue to measure and sample chicks in the coming seasons to make up for this shortfall.

4. Describe the involvement of local communities and how they have benefited from the project.

When in the field we engaged with local field rangers, environmental monitors and lodge managers who joined us with nest checks and nest installations. This gave us an opportunity to share our work and allowed rangers to learn and share new and interesting information with their guests as well as their families in rural communities.

Guides and rangers also contribute towards the conservation of the species by sending us details on sightings of the birds.

Rhino poaching in the area is one of the main work focus and topics of discussion for rangers and environmental monitors and it's important for them to learn about other environmental impacts on other species, to see the bigger picture, and also to hear positive conservation outcomes from other projects. We hope it inspired them in their work, which can often feel hopeless, when facing the depressing reality of poaching.

5. Are there any plans to continue this work?

Yes, the APNR Ground-Hornbill project is an ongoing long-term project and nest monitoring, and research will continue. We aim to strengthen our work on educational outreach to local communities.

This study on the effects of high temperatures on nestling growth and physiology has been extended and upgraded to a PhD study due to its scope. Data collection on this study will continue for 2 – 3 more years, to allow for a more robust study with larger sample sizes. Data will also be collected to incorporate additional questions. I aim to investigate the effects of high temperatures on: 1) ground-hornbills behaviour and landscape use, and 2) maternal allocation (egg size).

We also aim to expand the current study site into neighbouring reserves that do not have breeding groups of ground-hornbills. We will visit these sites to look for potential nests and install artificial nests if natural nests are not found in the area. This will help the current population of ground-hornbills to expand out of the area into new territories which will help to increase their breeding success and numbers.



Installing new artificial nests with the help of field rangers and guides.

6. How do you plan to share the results of your work with others?

We produce a quarterly report to the reserves' landowners, management, lodges, and field guides. We publish articles in local magazines and newspapers. We also give talks to local communities, in workshops, webinars and scientific conferences. I presented some of my preliminary results at the biannual Hot Birds Research Conference, held in person, and at the annual Ground-Hornbill Working Group meeting, held online. Results from this research will be published in peer reviewed scientific papers.

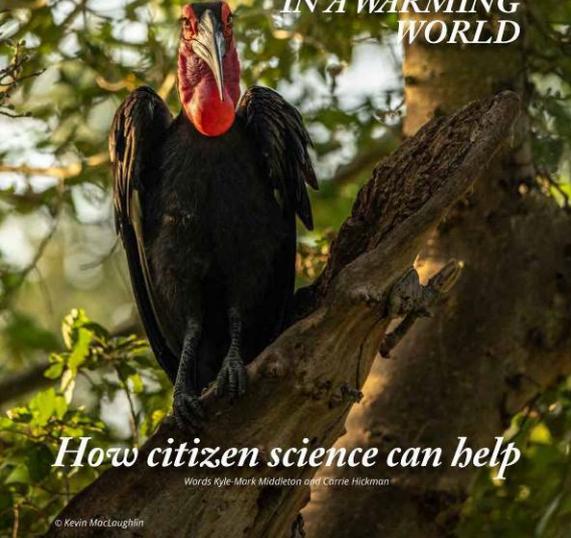
The project has a very active presence on social media, where camera trap videos, field activities and photos are shared with the public. This has been received very well and has increased our online following and species awareness.

You can view our Facebook page here: [GroundHornbillResearch](#) and Instagram page here: [apnr_ground_hornbill_project](#)

I am hoping to attend the Pan African Ornithological Congress in Nov 2022 where I will present some of my findings.

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GROUND-HORN BILLS IN A WARMING WORLD



How citizen science can help
Words Kyle-Mark Middleton and Corrie Hickman

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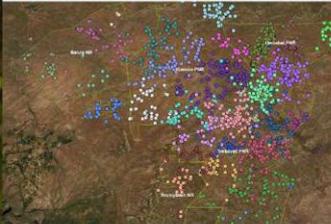
The Associated Private Nature Reserve (APNR) Ground-Hornbill Project relies heavily on sightings of the birds from guides, reserve staff and the general public. Reporting these sightings may sometimes feel meaningless, but each report is completely invaluable to both our research and the national monitoring of the species.

Each time a sighting is reported with a location, it is inserted into our database and mapped. This allows us to gain an understanding of the different groups within the area, their group sizes, group compositions, as well as their movements and home ranges. Additionally, these sightings often provide us with information on the breeding status of the groups and help us determine whether or not to install artificial nests. However, in order to do this, we need a lot of data. Data that is impossible to gather without the help of citizen scientists.

Citizen science has become increasingly popular over recent years and is recognised as an effective tool in research and conservation, while simultaneously involving and connecting the general public to important scientific questions.

The GHP is currently embarking on a new and important research question by investigating how the birds will cope in a rapidly warming climate. This research will contribute towards the bigger picture of how Ground-Hornbills as well as other bird species might respond to climate change, and where our conservation efforts should be aimed. There are two broad angles from which we are looking at this.

Firstly, using the project's long-term data, we can analyse the role which temperature plays in their breeding success, and whether the fact that they are social animals allows them to buffer the harsh conditions and breed successfully. Secondly, we can use behavioural observations to see at what temperatures the birds tend to change their behaviours. For example, on hot days, birds may need to spend more time in the shade of trees to cool down, and therefore are disadvantaged by missing out on foraging opportunities. If there are increasingly hot days over a prolonged period, this could have a



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negative impact on the birds' overall condition and could deter them from breeding in that season. Even if breeding does occur, increasingly hot days could result in the nestlings within the nest receiving less food since parents and helpers will need to spend more time cooling down and feeding themselves, rather than gathering food and feeding their offspring.

Birds are amazing creatures and have several ways in which they can thermoregulate. They can drop their wings to increase air flow over the skin; they can open their beaks to pant; and of course, they can move to shaded areas and up into trees to get away from the hot ground surface. However, in order to see how the changing climate might affect them, we need to know at what temperatures these behaviours begin to happen.

To date, we have been using the photos and videos the project has collected, but we are now looking at using citizen science to gather additional footage of the birds and we urge anyone who has footage of the birds (photos and especially videos) to please send them to us. It is important to include the date, time and the general location where the photo or video was taken. By doing this, you will be helping us create a robust study and provide a platform for us to base future conservation efforts on this species and others. ■

"The GHP is currently embarking on a new and important research question by investigating how the birds will cope in a rapidly warming climate."

We need your help

The APNR Ground-Hornbill Project are calling on citizen scientists to report sightings of this bird.

If you see a Ground-Hornbill, take a photo or video and record the date, time and location of sighting. Email this to rgh@rufford.org or WhatsApp @ to +2772 345 6584.

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CAUGHT on camera

Words Chloë Cooper | Photos APNR Ground Hornbill Project



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"Camera traps play a crucial role in helping the team observe and understand the natural behaviour and environmental factors impacting the survival of the chicks"

the survival of the chicks and the dynamics of the groups. Curious creatures like baboons, or birds of prey which might utilise an empty nest, or predatory species like genets and leopards are all "seen while no one's looking" and so offer a rare and unique insight into life in the wild.

This season, the camera trap revealed an unfortunate incident of predation on a 20-day-old chick in the Johnniesdale nest. "The leopard spent an entire day in the nest tree before the nestling was eventually pulled out and dropped. We knew we'd arrived at the nest shortly after this occurred as we subsequently ended up chasing the leopard away," said Carrie.

KLASERIE CHRONICLE | ISSUE 56 RESEARCH

Unfortunately for the Johnniesdale group, they lost this year's chick. The camera trap video revealed all, allowing us an exceptional insight into the challenges faced by these birds as well as by the project itself: The leopard easily accesses the nest, which has a hole large enough to allow the adult female Ground Hornbill in and out the nest. Its natural curiosity and instinct to make a meal out of what is available means that this type of predation occurs frequently in the wild ecosystem of the Greater Kruger.

Whilst predation is a natural cause of death for Ground Hornbill chicks, the project is investigating ways to possibly protect the nestlings from a variety of nimble predators such as leopards, genets, snakes, and baboons. There is no one-size-fits-all solution, and while our human emotions sometimes get in the way of nature's cycle, an incident like this is a natural thing.

This particular group of birds has had successful breeding years in the past. In fact, the population of Southern Ground-hornbills in the Associated Private Nature Reserves (APNR) has a two to three times higher breeding success rate than groups elsewhere in South Africa, likely due to the implementation of artificial nests. The project - which has been running for over 22 years - continues to adapt to the changing climate and other environmental factors impacting the survival of this endangered species.

Keep an eye on the project's social media channels for more behind-the-scenes camera trap footage and information on how you can help support their conservation work: [@APNR_ground_hornbill_project](https://www.facebook.com/APNR_ground_hornbill_project) ■

It's almost the end of the breeding season for Southern Ground-hornbills, and the team at the APNR Ground Hornbill Project have been hard at work monitoring groups with new nestlings across the Greater Kruger. Part of this year's cycle was successfully harvesting redundant second-hatchlings handed over to partner organisation, the Mafusa Ground Hornbill Project, to be reared and eventually released back into their historic range (which

has declined by up to 70% in the past century). Every year comes with its surprises, and the team prepares themselves for what might become of the newly hatched chicks as they enter their world in the wild.

"The breeding season got off to a slow start this year, with the first eggs of the season only being laid in early-November. There was a total of 13 breeding groups, of which there are currently eight remaining. Four of the

five failures occurred from predation and an unknown cause, occurring shortly after the chicks hatched. The final failure was due to a congenital deformity which unfortunately led to underdevelopment and the death of the chick at 45 days old," said project researcher, Carrie Hickman.

Camera traps play a crucial role in helping the team observe and understand the natural behaviour and environmental factors impacting

Some of our popular articles published in local magazine - Klaserie Chronicle.

7. Looking ahead, what do you feel are the important next steps?

- Continue to monitor reproduction, collecting data on nestling growth and physiology.
- Install additional artificial nests beyond the study site to allow for the natural dispersal of ground-hornbills and repair old installed nests when needed.
- Expand the research into nearby neighbouring reserves if breeding sites are found.
- Grow the citizen science community, photos and videos submitted by citizen scientists can help us to identify meaningful temperature thresholds for the species and this is something I aim to investigate as part of my PhD study.
- Identify the operative environmental temperatures in microsites that the birds used. Interesting preliminary results show that winters might feel be hotter to the birds than summers. We intend to investigate this by measuring temperatures in different microsites. This will help to identify thermal threshold temperatures and inform land management practices.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, the Rufford Foundation logo was used in all our reports and on our acknowledgement page at the end of every presentation and webinar given. Further acknowledgement of the support received from The Rufford Foundation will be made in the publications that come from this research.

9. Provide a full list of all the members of your team and their role in the project.

Carrie Hickman – PhD candidate (upgraded from MSc) and principal researcher on this project “Effects of high temperatures on nestling growth & physiology”

Kyle-Mark Middleton – Field assistant and currently a PhD candidate at FitzPatrick Institute with APNR Ground-Hornbill Project. Assists with data collection in the field.

Dr Rita Covas – Academic supervisor (University of Porto/FitzPatrick Institute of African Ornithology) on this research project and APNR Ground-Hornbill Project research coordinator.

Dr Susan Cunningham - Academic supervisor (FitzPatrick Institute of African Ornithology) on this research project and Hot Birds Research Project coordinator.

Dr Francois Criscuolo – Researcher at CNRS, Strasbourg France who is supervising the telomere analyses at his laboratory in Strasbourg.

Thandiwe Knutson – Field and data entry assistant.

10. Any other comments?

The support from The Rufford Foundation has allowed this project to grow and has opened up opportunities for future vital research on the species. This research is directly adding to knowledge on ground-hornbills and playing a vital role in their conservation. Thank you massively for funding this project and we hope that The Rufford Foundation will support our future work, expanding on the current research topics.



Staying safe during nest checks with new ladder and climbing equipment funded by The Rufford Foundation.