Nigerian Montane Forest Project

Montane Forest Conservation Initiative Nigeria

NIGERIAN MONTANE FOREST PROJECT
NGEL-NYAKI

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Annual Report

UC SCIENCE

2018

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Report design and production by Matt Walters, Univeristy of Canterbury.

Introduction

Anastasios (Tasso) Paul Leventis - Patron

Phil Hall (Chair)

John Adeyemi Adeleke

Danladi Umar

Hazel Chapman

Welcome to our 2018 annual report, which summarises our most challenging year yet. However, despite all the difficulties, the dedication, courage and hard work of our staff have carried the project through and we remain in a strong position - with many successes to report.

In March, unknown assailants attacked Yelwa village. During the attack we lost our much loved field assistant, Musa Buwaro, who has been with the Project since 2003 (see page 6). We shall all miss Musa greatly and once again extend our condolences to his family.

Two fires, deliberately lit and associated with the attack, have temporarily destroyed our forest regeneration plots. Bad though this is, the fires have presented us with an opportunity to understand how regeneration occurs after fire and which species are most fire tolerant, and we are basing our new planting schedule on these findings.

All our long- term research continues, as do ongoing PhD projects and several others associated with the CTFS FOREST_GEO plot. Undergraduate Nigerian industrial training (IT) students are with us as usual, working with field assistants and carrying out their own research projects.

Elisha Emmanuel Barde, our new science coordinator, visits Ngel Nyaki on a regular basis. Elisha has instigated several successful expeditions round the reserve assessing threats to conservation, botanising and meeting with our isolated neighbouring communities (page 8).

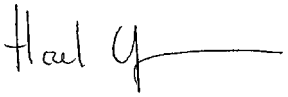
International interest and logistical support illustrate the value of the Project beyond Nigeria – we are contributing to the Kew Gardens Millennial Seed Bank and collaborating with Exeter University et al's NERC funded investigation into the effect of lightning strikes on tree death. We are partners in the Colorado State University Cloud Forest study into rates of litter decomposition in tropical cloud forests. I have received many more requests from international researchers wanting to work at Ngel Nyaki, but most of these are on hold for the short term.

National interest in the project continues to grow as illustrated by visits to the Project by the Nigerian United Nations FAO team to quantify carbon sequestration in Ngel Nyaki forest and by increased collaboration with the Nigerian Conservation Foundation. We are aligned strongly with the newly established Africa Nature Investors Foundation, particularly in projects around Gashaka Gumpti national park.

This year our two T.Y. Danjuma Scholars graduated with PhD's (Page 12) and two other PhD candidates are continuing to collact data and write up their theses (Page 14). Our outputs are as high as ever this year with 12 published papers in peer review journals and 11 conference contributions (page 23).

We are extremely grateful to Chester Zoo and the A.G. Leventis Foundation for their continued support. Never has it meant so much because some funders have suspended their support until circumstances improve in Taraba.

The current situation is affecting our intake of international postgraduate students, and I have not visited the field station since March. A positive spinoff from this is that the project is becoming more independent and Nigerian focused. Under Dr Danladi Umar's direction, Misa Zubairu's leadership and the commitment of all staff the project remains well intact. I have become more of a science director and mentor.



Hazel Chapman
Director, Nigerian Montane Forest Project

Our values

Mission Statement

To promote national and international commitment to the conservation of Nigeria's montane forests by inspiring excellence in research by postgraduate students and empowering local communities through employment and education.

Aims

1. To combine scientific research with education at both tertiary and local community level in order to develop long term sustainable management of Nigeria's montane forests.

2. To facilitate the involvement of national and international researchers in Nigerian montane forest research.

3. To involve the community in the management of montane forest ecosystems.

4. To work with the community in other ways, such as developing small businesses and working with schools to develop conservation awareness.

Our networks

Project Partners / Collaborators

A.P. Leventis Ornithological Research Institute (APLORI), Jos, Nigeria
Chester Zoo, England
Gashaka Biodiversity Project, England/Nigeria
Gombe State University (GSU), Nigeria
Mayfield Community Ecology Laboratory, The University of Queensland, Australia
Nigerian Conservation Foundation (NCF), Nigeria
Nigerian National Parks (NNP), Nigeria
Prof Colin Chapman (McGill University, Canada and Kibale Monkey Project, Uganda)
Prof Mike Lawes (University of KwaZulu-Natal, South Africa)
Prof Pierre-Michel Forget, Natural History Museum, Paris, France
Royal Botanic Gardens, Kew, England
Smithsonian Tropical Research Institute-ForestGEO, USA
Taraba State Government, Nigeria
Taraba State University (TSU), Nigeria
University of Canterbury (UC), New Zealand
University of Exeter (United Kingdom)

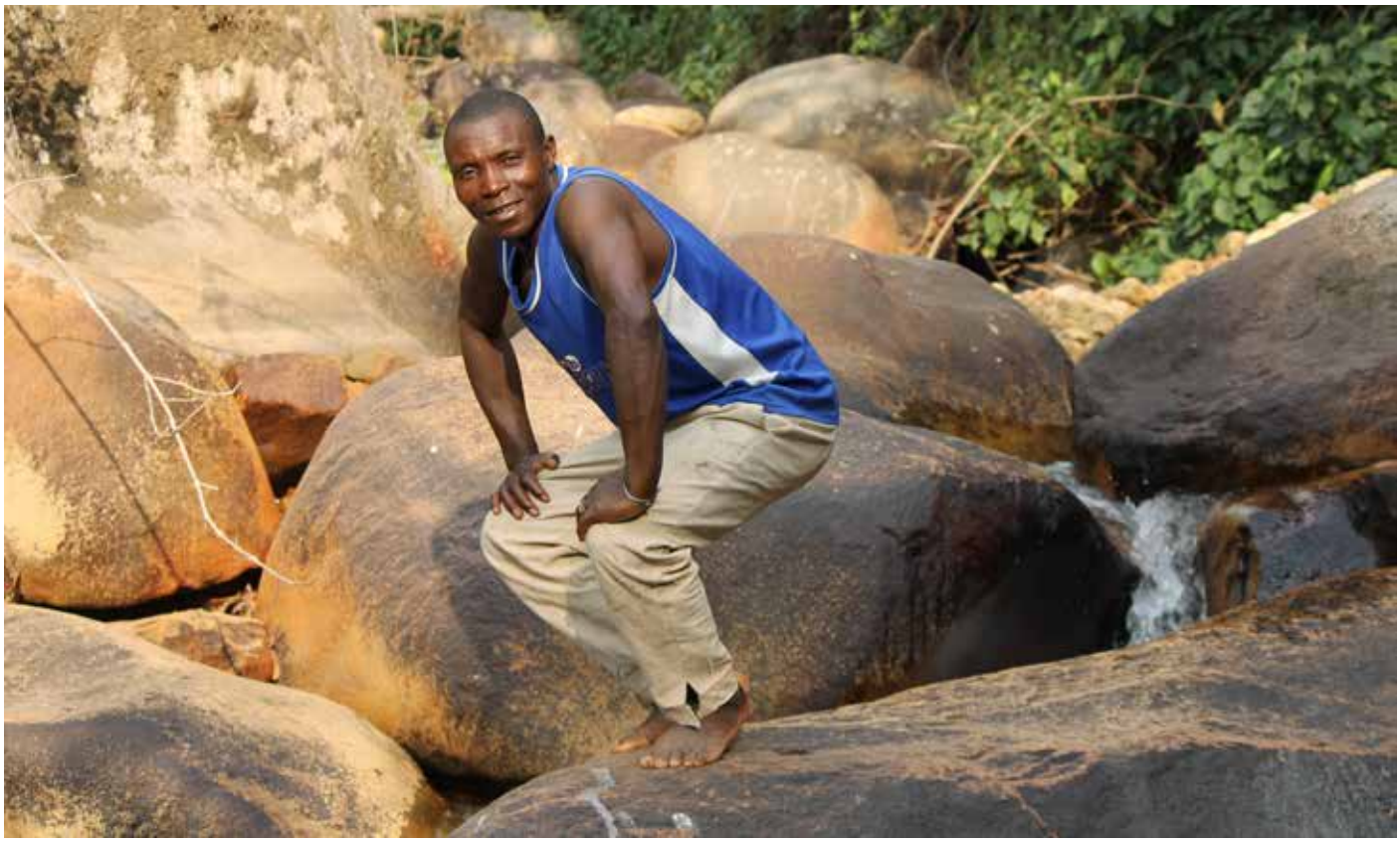
Project Funders

A.G. Leventis Foundation
A.P. (Tasso) Leventis
Chester Zoo
NEXEN- a wholly owned subsidiary of CNOOC Limited
University of Canterbury, NZ

Academic Supervisors

Assoc Prof Hazel Chapman (UC)
Dr Alexander Christianini (Federal University São Carlos, Brazil)
Prof Will Creswell (University of St Andrews, UK)
Dr Matthius Deling (UC)
Prof Ian Dickie (UC)
Prof Pierre-Michel Forget (Natural History Museum, Paris, France)
Dr Daniel Gerhard (UC)
Dr William Godsoe (Bio-Protection, Lincoln University, NZ)
Dr David Kenfack (Smithsonian Institute, Washington D.C. USA)
Prof Mike Lawes (University of KwaZulu-Natal, South Africa)
Dr Shiiwua Manu (APLORI)
Dr Roger Pech (Landcare Research, Lincoln, NZ)

In memoriam



Musa Buwaro

"You can't do a darn thing in the field without a good field assistant"[1]

Musa was one of the best. Primarily a primatologist, he was one of the very first field assistants employed by the Project. In 2003 Musa worked with BSc Hons. student Josie Beck, on an investigation into the size of the chimpanzee population within Ngel Nyaki forest. He went on to become an expert on the putty nose monkeys in the reserve, semi-habituating two groups for Stephen Gawaisa's PhD research into putty nose's role in seed dispersal, and Kelly Hutchinson's MSc research into putty nose feeding ecology. Musa also assisted Abby Grassham in her MSc study into seed dispersal by tantalus monkeys. In addition to primate work, Musa worked with Jennifer Agaldo and Sasha Roselli on seed dispersal by ants and made numerous other contributions to a wide range of research projects. We all sorely miss him.

https://www.zoology.ubc.ca/~macdonald/curious_interactions/tips-for-a-successful-field-assistant-researcher-relationship/

True heros

During and following the March crisis, some heroic action deserves mention.

On the morning of the attack, Usman Abubakar, project deputy manager, literally risked his life to ensure Silveo Stivanello, our Italian colleague, was safe. Usman left the safety of his home and took a bike to the field station to collect Silveo and send him to safety in Gembu.

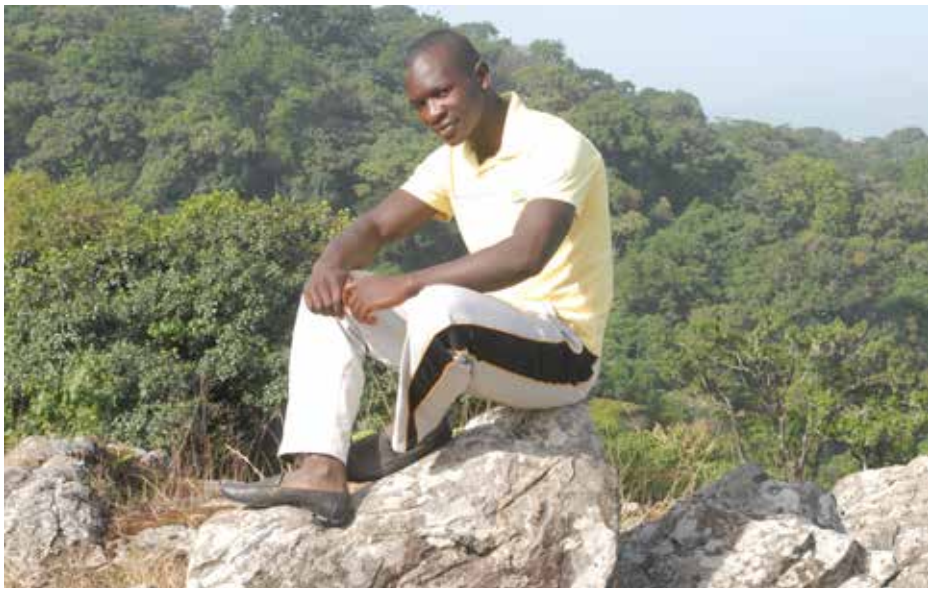
Elisha, Ridwan, Aliyu, Usman and Manu escaped into the forest but climbed a hill to observe all that was going on. They took photographs and immediately it was safe, they returned to the field station to collect the litter samples to take to Jos to dry (page 18).

Following the trouble, Misa Zubairu, project manager, made a huge effort to help all our staff and other families in the community, many of whom had lost their home and/or family members- making sure they had food and accommodation. Misa has since kept the project going throughout the year. Immediately following the fires he organised the re-building of fences for forest restoration plots and the forest nursery.

Our maigadis (watchmen) Bobo Zubairu and Manu Abubakar continued to look after the field station during what must have been extremely anxious times.

Dr Danladi Umar travelled to Ngel Nyaki as soon as was feasible to meet with Misa and Usman and see for himself the extent of the damage. Danladi provided sound advice, moral support and encouragement.

Bobo Zubairu and Manu Abubakar



Usman Abubakar

Misa and Danladi viewing damage to trees in the regeneration plots following deliberately lit fires in March, 2018. Following this, research will involve scoring trees for i) death, ii) top burn only and iii) resprouting. Choosing species which re-sprout following fire will be a priority from now on.

Elisha Emmanuel Barde with Ridwan Jafar at the 6th Biodiversity Conference, Nigeria, a Chapter of the Society for Conservation Biology (NSCB) 6–12 May 2018.

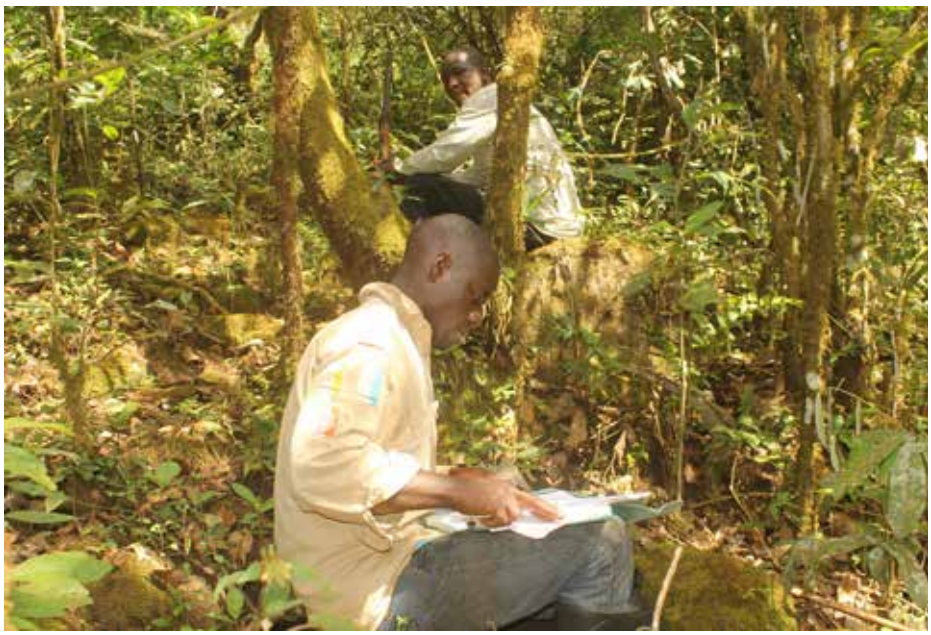
Expeditions around the reserve

The first 2018 expedition around the reserve, led by Elisha Emmanuel, to collect plant specimens and engage with the local community. From left to right: Usman Abubakar, Alfred Christopher, Elisha, Emmanuel John Tha, (IT student) YunusaSani (IT student) Ali Bapetel. In front is ranger Dawda.

During 2018 Elisha Emmanuel, our new science coordinator, organised five expeditions round Ngel Nyaki forest reserve with four aims:

i) Collecting seeds for the Royal Botanical Gardens, Kew Millennium Seed Bank Project

The team was successful in collecting and thoroughly drying sufficient seeds of: *Bridelia speciosa, Pittospermum virdiflora, Psorospermum aurantiacum, Uapaca guineensis* and *Warneckia* sp. We are grateful to Xander van der Burg (Kew) for supplying the silica gel for the collections, Phil Hall, Dr. Shiiwua Manu and Elisha Emmanuel (Aplori) for organising transport of the silica gel from Aplori to Ngel Nyaki and Chris Naylor (A Rocha International) for taking the seeds back to the UK for us.



Alfred Christopher filling in the data sheet associated with seed collecting for the Millennial Seed Bank Project.

ii) Adding collections to our forest herbarium

The team added fifteen tree species to our NMFP herbarium collections, including four unidentified species: *Simphonia* sp. (Clusiaceae) (in addition to *S. globulifera*); two species of Fabaceae, resembling the common *Anthonotha noldae; Deinbollia* sp. (Sapindaceae), in addition to *D. pinnata*. This brings the number of tree species in Ngel Nyaki forest to at least 120.

iii) Assessing levels of felling, farming, poaching and cattle incursions into the forest.

During the first expedition in February 2018 Elisha and his team found that while some areas of forest near to the field station are regenerating well, areas of the reserve farther away are suffering badly from human and cattle incursions. Elisha has produced a detailed report with photographs and names.

When the team visited Kurmin Danko and Ndombo Ngishi they found much devastation. Apparently one of the lead forestry patrollers, Sargent Paul (Saidu) has given permission for the local communities to fell trees, graze cattle and practice slash and burn agriculture. We have a list of names of people felling trees and farming.

In addition, African Rosewood (Madrid) *Pterocarpus erinaceus* is being logged for export to China. Old and newly felled logs are lying, scattered across areas of Ngel Nyaki reserve waiting to be collected- in some places temporary roads have been cleared for this purpose.

Barbwire fences are being built within the reserve, with extensive areas being cleared for farming.

The forest patrollers outposts, built by the RSPB/NCF Darwin Initiative project in 2003–5 are abandoned and roofless; no patrollers were found on duty and two of them (who remain anonymous) say they have been threatened with their jobs if they report illegal activities.

Twelve boundary beacons and signs have been removed. When the NCF re surveyed the reserve boundary in ~ 2003–5 they failed to follow the original boundary, so that now a large part of the reserve is 'owned' by individuals who are putting great pressure on the reserve.

The herbarium team changing the papers in the presses. This needs doing on a daily basis until the specimens are completely dry. At Ngel Nyaki we dry papers in the sun during the dry season and over a charcoal oven in the rains. L–R Ali Bapetel, Hammasumo Ibrahim, Jafaru Bapetel and Adams Hassan.

Panso residents. Life in the villages/hamlets in the vicinity of Ngel Nyaki reserve (with the exception of Yelwa village) is extremely hard. Women regularly undertake a four hour, uphill walk onto the Plateau to take banana and other produce to Yelwa to sell. These settlements need help; they lack schools and any sort of health care.

On a subsequent expedition a new development was discovered; the collection of lichens from forest trees. Large quantities of lichens are dried and transported south sell as food supplements. The lichen does appear to grow back quickly (see photo page 25).

iv) Meeting with neighbouring communities to improve community awareness

Meeting with communities was hindered this year because of the unavailability of the village elders, Panso village being an exception. Here the villagers complained of how the reserve appears to be unprotected. Farther meetings are essential.

Nine recommendations follow from the expedition report:

1. The Ngel Nyaki forest reserve boundary needs re-surveying to its original plan. Large beacons, made with metal drums and filled with concrete (as in Gashaka Gumti National park) need to be erected around the boundary.
2. There is need to have a buffer zone of at least 1 km around the entire reserve.
3. There is a need for a community-conservation awareness program for all communities around the reserve.
4. Taraba State Forestry should maintain the outposts and ensure that patrollers are stationed in them and doing their work.
5. Patrollers should report to the Ngel Nyaki field station before and after each shift.
6. Patrollers should have security and communication devices such as radios and motor bikes.
7. Communities around the reserve should be encouraged to become stakeholders in the reserve.
8. Expeditions by the NMFP and collaborators including Taraba State Forestry should be organized three times in a year in order to assess the status of the forest.

Abandoned patrollers camp built by NCF/ DFID in 2005.

A felled rosewood tree for future sale in China.

Cattle within the reserve.

Forest regeneration- green shoots after the fires

This image shows how devastating the fires have been - prior to the fire the left side of the fence was covered in dense, tall grass.

Following the January and March fires we monitored the fate of the trees we had planted as part of our forest regeneration program. Approximately 70 % of the planted trees are regenerating after the fire but there are clear species differences. Individuals above 2 m in height are generally unharmed. Smaller individuals (mostly above 1 m in height) of *Psychotria umbellata* and *Syzygium guineensis* are re-sprouting well. In contrast individuals of *Polyscias fluva*, *Anthonotha noldae*, *Bridelia speciosa* and *Canthium vulgare* have almost all died. Of note is that the fire seems to have stimulated the germination of many savanna tree seedlings.

The fires spread into the forest in some places. When this happens trees can smoulder for days and it is important to put the fire out completely. Here the field assistants are carrying buckets of water to pour over smouldering logs.

Postgraduate student update

The two T.Y. Danjuma Scholars, Biplang Yadok and Jennifer Arubemi Agaldo, graduated in December with Doctor of Philosophy in Ecology.

Ecological behaviour of the African giant pouched rat (*Cricetomys* sp. nov): implications for foraging and seed dispersal of large-seeded species in a West African montane forest landscape.

Dr Yadok Biplang Godwill

Biplang has already published one paper in the African Journal of Ecology and several more are in preparation. He is hoping to be successful in an Endeavour Post Doctoral Fellowship to work with Dr Renee Firman at the University of Western Australia (UWA). His research will be into the sociality of the western pebble-mound mouse, a burrowing rodent whose habitat is being lost to mining activity in that region.

Following on from his post-doc, Biplang plans to return to Nigeria to work in academia.

The Role of Ants in Seed Dispersal and Regeneration in a Degraded West African montane Forest-grassland Landscape, Ngel Nyaki Forest Reserve, Nigeria.

Dr Jennifer Arubemi Agaldo

Jen has so far written two papers from her thesis, one on ant diversity and the other about ants and seed dispersal. They will be published during 2019.

Jen is currently working on her papers before looking for a post-doc.

One again we thank retired General T.Y. Danjuma for his support of these two excellent students.

https://www.canterbury.ac.nz/media/documents/research/research-reports/Research_Report_2017.pdf

This research will help inform Nigeria's montane forest managers on how best to manage rats, in turn aiding passive restoration and sustainable management of the forests.

Biplang Yadok (holding camera) and field assistants setting up camera traps in Ngel Nyaki forest, Nigeria. Photo: Biplang Yadok

Rats to the rescue in Africa's montane forests

Through the Nigerian Montane Forest Project, the School of Biological Sciences | Te Kura Pūtaiao Koiora is promoting African montane forest conservation and fostering related postgraduate research.

Having grown up in Nigeria as the child of a forest botanist, evolutionary ecologist Associate Professor Hazel Chapman has long had a fascination with the plants and animals of Nigeria's montane forests, but has also seen the biodiversity of these forests shrink alarmingly over the past 30 years.

Following a survey of Nigeria's montane forests in 2001, Associate Professor Chapman decided to take action. With the help of the local Nigerian community and funding support from Chester Zoo, the World Wildlife Fund (WWF) and Nexen Nigeria, a field station was built on the edge of Ngel Nyaki Forest Reserve in Nigeria's Taraba State. This marked the start of UC's ongoing relationship with the reserve and the founding of the Nigerian Montane Forest Project (NMFP).

The goal has been to combine scientific research with field education in order to promote sustainable management of Nigeria's montane forests. Since 2005, 23 postgraduate students from Nigeria and Aotearoa New Zealand have graduated. The project is also linked into the international research community through the Smithsonian Institute.

Even though Aotearoa New Zealand is a long way from Nigeria, UC doctoral student and Nigerian ecologist Biplang Yadok did not hesitate about taking the opportunity to pursue doctoral study at UC under the supervision of NMFP founder Associate Professor Chapman. Previously, he had studied at Nigeria's A.P. Leventis Ornithological Research Institute and had met Associate Professor Chapman before getting involved with NMFP's conservation work.

"It has provided me with a unique opportunity to study ecology in my home country, and at the same time have access to key researchers at UC and Landcare Research," says Biplang.

The role of rodents

Since commencing his doctorate in February 2015, Biplang has focused on exploring the potential of rodents to act as secondary seed dispersers. This is of critical importance to forests such as Ngel Nyaki, where elephants are now locally extinct and very few chimpanzees remain. These animals dispersed the large seeds of several tree species, by eating their fruit. Research conducted by a former doctoral student, Babale Aliyu, identified a large rodent – the African giant pouched rat (*Cricetomys* sp. nov.) – as a potential substitute seed disperser.

In the Neotropical realm – South America, Central America, and the Caribbean – where most megafauna went extinct about 10,000 years ago, it is already established that rodents effectively disperse large seeds through scatter hoarding.

Biplang used a variety of methods to study the ecology of *Cricetomys* and how it may serve as an agent for montane forest conservation. Interestingly, some techniques used to measure rat density were developed in Aotearoa New Zealand and Australia and are new to Afrotropical research.

His results are significant, showing that this African rat is very much a forest dweller and the seed predation/dispersal ratio is unaffected by season, seed size or seed species. The one factor driving seed fate is nutrient content.

"Of note is that the species with the highest fat content is *Carapa oreophila*, adapted for dispersal by now locally extinct elephants," says Biplang.

While much remains to be learned about Cricetomys, Biplang hopes his research will help inform forest managers on how best to manage these rats so that they aid passive forest restoration.

Along with Associate Professor Chapman, Biplang's supervisory team includes pest specialist Dr Roger Pech of Landcare Research Lincoln | Manaaki Whenua, Dr Daniel Gerhard of UC's Department of Mathematics and Statistics, and French natural historian Professor Pierre-Michel, an international expert on scatter-hoarding rodents.

Global awareness

Biplang says studying at UC has been a remarkable experience.

Biplang hopes his research will help inform forest managers on how best to manage these rats so that they aid passive forest restoration.

"The close relationship between postgraduate students and academic staff here is not something I could have experienced in Nigeria and I am now connected to many scientists here and around the world. Most importantly, my stay here has exposed me to research interests that have barely been investigated in Nigeria and Africa."

Associate Professor Chapman says Biplang's work is a major contribution to understanding not only *Cricetomys*' role as a substitute seed disperser but also to the overall ecology of this rodent. The research also places him at the forefront of conservation and biodiversity research in Nigeria as well.

Funding for the research came from a variety of sources including Nigerian philanthropist T.Y. Danjuma, Chester Zoo, the A.G. Leventis Foundation, Idea Wild, the Rufford Small Grants Foundation and the Animal Behaviour Society.

Ongoing PhD studies

Report by Murna Tela

Field assistants and IT students have continued on collecting data for Murna Tela for her PhD thesis. Here they removing the large cages which were placed over maize plants as part of an investigation into pest control by insectivorous birds. L-R Usman Bashiru, Yakubu Vugeh, Praise John, Elisha Emmanuel and Yanusa Sani.

The value of forest fragments in maintaining avian functional diversity and associated ecosystem services within a West African agricultural landscape

Murna Tela PhD NZ Development Scholarship

Field assistants Yakubu Vugeh, Ahamadu Usman and Usman Bashiru

Forest-agricultural mosaics are common ecosystems in Nigeria and in montane habitats the forest fragments support a rich diversity of bird species. While some of these species may be providing pest control services to agricultural crops, the future of the forest fragments is threatened because they are being farmed. Therefore, it is important that we understand whether small forest fragments provide ecosystem services to surrounding crop species by being habitat for birds which control insect pests of crops.

As part of my thesis, I quantified the pest control services provided by birds to farmers and identified their contribution to crop productivity in *Zea mays*, the most common crop on the Mambilla Plateau.

Since last year, I have continued to carry out fieldwork to monitor bird species across 36 farmlands and 22 forest fragments and classified each species into a feeding guild. I used exclosure experiments (using a series of caged vs open maize plots across the Mambilla Plateau) to test my hypothesis. My hypothesis is that (i) if birds are excluded from contact with the maize plants, more insects will attack the crop and productivity will be reduced. (ii the retention of forest fragments close to maize farms will have effects on crop yield in Mambilla farmlands via increasing pest control services provided by birds' diversity and richness

Key findings this year;

1. Crop yield was higher in the control treatments where insectivorous birds were present than in the bird excluded treatments.
2. Crop yield increased with an increase in insectivorous species in the control treatment but decreased when birds were excluded.
3. The retention of forest fragment close to farmlands have no positive effect on crop yield via increasing pest control by insectivorous birds.
4. Crop yield increased with increase in distance of farmlands from forest fragments for both treatments.

Overall, my exclosure experiment showed that insectivorous bird abundance played an important role in pest control in Mambilla maize farmlands, leading to an increase in crop yield. Although forest proximity to farmlands can be essential for enhancing crop productivity, this might not be so for Nigerian farmlands. For farmlands at Mambilla, the retention of forest fragments away from these farms (e.g. land sparing in which land conservation is held separate, and away from crop production) may be the best overall conservation strategy.

Report by Iveren Abiem

Woody plant composition and diversity and the role of density dependence in an African Montane Forest

Iveren Abiem PhD

Field assistants Helen Andrew, Dahiru Zubairu, Joel Idi, Enoch Zaccheus, Auwal Sajo, Abubakar Musa and Ahmadu Salihu

Tropical forests are experiencing and are predicted to experience changes leading to loss of organisms as well as key interactions. Understanding species composition patterns and processes that drive them is important in forest management and regeneration. Many studies investigating species composition and diversity patterns have focused on lowland forests where most of terrestrial biodiversity is found but Montane forests are important biodiversity hotspots too and understanding processes that generate and maintain plant composition and diversity patterns in this ecosystem will help in their management.

My study site is the 20 hectares Ngel Nyaki Forest GEO plot where we have recorded 41,031 woody individuals belonging to 106 species measuring ≥1 cm diameter at breast height (dbh) measured at 1.3m above the ground. I set up seed traps and established 1 m^2 plots besides them to measure seed arrival patterns and recorded recruiting seedlings. I also and established seedling density and diversity throughout the plot. I also established a 1 m^2 seedling plot in the center of every 5 x 5 m section of the 20.28 ha plot giving us 8,112 of these seedling plots.

I recorded a total of 3600 undamaged seeds representing 31 species from 106 seed traps in 49 weekly censuses, 1515 recruited seedlings representing 51 species from 318, 1 m^2 seedling plots and 11,918 established seedlings representing 84 species from 8,112, 1 m^2 seedling plots. Seeds and seedlings comprised of tree, shrub and liana species. Of the 106-species recorded from the census of trees with dbh ≥ 1cm, 28 were represented in the seed census, 39 in the recruited seedling census and 65 in the established seedling census. Diversity was lower in the seedling layer compared to stems ≥ 1cm dbh. The species that dominated the regeneration layer included mostly understory species of the forest- *Psychotria peduncularis* (Rubiaceae), *Garcinia smeathmannii* (Clusiaceae), *Isolona* sp. (Annonaceae), *Dracaena* sp. (Asparagaceae), *Campylospermum flavum* (Ochnaceae) and the seedlings of two lianas *Paulinia pinnata* (Sapindaceae) and *Landolphia* sp. (Apocynaceae). The most abundant species as seedlings were also the most abundant as adults.

Iveren Abiem in the nursery recording data on seedling survival as part of her study into negative density dependence. Iveren is testing the effect of varying densities of con-specific and interspecific seeds on seedling survival.

After a seedling re-census, I used a neighbourhood model of seedling survival to model the probability of an individual seedling's survival as a function of the density and identity of its seedling neighbours and adult neighbours. What I found which is contrary to findings from lowland forests, is that the probability of seedling survival was higher in denser neighbourhoods and seedlings do not seem to mind having neighbours of same species. This is in contrast to one of the most popular hypotheses used to explain forest diversity and has received strong empirical support - the Janzel-Connell hypothesis (or enemies' hypothesis) which proposes that species are inhibited when they are locally abundant because they are regulated by specialized natural enemies thus the establishment of other species is promoted, bringing about diversity. This result is not conclusive yet as I have conducted only one re-census. I would like to see if this pattern is maintained after conducting future recensuses.

I have also set up shade house and field experiments to investigate how different plant species respond to density effects and to test for negative plant-soil feedbacks. Results from this study will provide insight on mechanisms that drive and sustain species distribution and diversity patterns in Montane. This information can be used in the management of Ngel Nyaki Forest especially in planning restoration projects.

Our study at Ngel Nyaki is one of the few carried out in Africa to try to understand species distribution and diversity patterns in tropical forests. It is therefore relevant for understanding Afrotropical forests especially because these forests continue to be threatened.

Undergraduate students

L-R: Yunusa Sani (ATBU), Praise John TSU, Emmanuel John Tah - Modibbo Adama University of Technology, Yola and Rita Simon TSU.

Each year, undergraduate students from Nigerian universities have the opportunity to visit the Mambilla Plateau and work with the Nigerian Montane Forest Project. Students spend six months undertaking work experience- 'IT Industrial Training' as a requirement for their degrees. This year the project is hosting four students from three universities, Taraba State (TS), Ahmadu Tafawa Balewa University Bauchi (ATBU) and Modibbo Adama University of Technology, Yola.

These students feature throughout this report, illustrating the wealth of experience they gain from working at the NMFP.

Our past IT students are doing well

- Ridwan Jafar graduated with a 1st Class BSc in Ecology from ATBU and is currently shortlisted for a prestigious TROPIMUNDO scholarship for the Erasmus Mundus Masters Course in Tropical Biodiversity and Ecosystem.
- Fatsuma Olaleru has completed her PhD at University of Lagos and is currently applying for a postdoctoral fellowship to work with Professor Colin Chapman and myself in Kibale National Park, Uganda on the role of primates in Forest Conservation.
- Jedida Akawu - Assistant lecturer Biology, Gombe State University(GSU).
- Suleman Mohammed - Lecturer II Gombe State University (GSU), about to complete a PhD in Malaysia.
- Sadiq Abdullahi - Laboratory Technologist, Department of Biology, GSU Gombe.
- Dorange J. - Education Officer- Ministry of Education, Gombe State.
- Dorcas Bakari - Laboratory Technologist, Federal University Kashere.
- Nelly Joseph - Education Officer Ministry of Education, Taraba State.
- Moses Newton - Lecturer, Federal College of Horticulture, Dadin Kowa, Gombe State.

Undergraduate field trips

Four academic staff and 56 300-level students of Botany and Zoology from Taraba State University, Faculty of Biological Science visited us between 22nd and 24th February. The students were extremely interested to hear about all the science going on at Ngel Nyaki, for almost all of them it was their first time in such an environment. They learnt a whole suite of field techniques and participated well with questions.

Elisha Emmanuel (science coordinator) Misa Zubairu and Usman Abubakar organised the days.

Silveo Stivanello told the students about the Exeter University et al's research into the effect of lightning strikes on tree death.

Research update

CloudNet Decomposition Research

The NMFP is part of the NSF-funded CloudNet, a network of researchers with a focus on tropical montane science. As part of this, in July 2017 we joined (as the only African site) a global study into decomposition processes in forest soils.

The idea behind the project is that a cloud forest study with such a wide range will help evaluate the commonalities and contrasts in a key ecosystem process across tropical montane forests, as well as enabling comparisons with other ecosystems such as lowland tropical forests. The study, designed by Jim Dalling, Becky Ostertag and Patrick Martin uses methods that are directly comparable with a pantropical decomposition study conducted at 27 sites in lowland tropical forests (Powers *et al*. 2011).

The study used a short-term litterbag and 'popsicle stick' experiment to evaluate decomposition rates and processes of leaves and wood. Similar to the Powers *et al*. (2011) study, bay leaves were the common leaf standard. Bags were placed above and below ground and then removed and dry weighed after three and six months.

Our Ngel Nyaki data is now part of a large CloudNet spreadsheet, currently being analysed.

Elisha Emmanuel led the collection of the data, assisted by Ridwan Jafar, the IT students and the CTFS FOREST_Geo assistants including Dahiru Zubairu and Enoch Zacchaeus.

Elisha Emmanuel and the team collecting the litter bags for the CloudNet decomposition study. The bags and popsicle sticks were collected after 3 months and 6 months. They were then weighed to constant weight so such that the difference in dry weights is indicative of litter decomposition rates. The data are currently being analysed by Professor Jim Dalling at the University of Illinois.

Powers, J.S. & Salute, S. (2011) Macro- and micronutrient effects on decomposition of leaf litter from two tropical tree species: inferences from a short-term laboratory incubation. Plant Soil 342:245-257.

Ngel Nyaki part of REDD+ National Forest Inventory

A light intensity national forest inventory exercise is ongoing in Nigeria as part of the REDD+ programme. The inventory, led by Prof. Shedrack Akindele of the Nigerian office of the Food and Agriculture Organization of the United Nations (FAO), involves sampling each ecological zone in Nigeria. Because of the NMFP, Ngel Nyaki was chosen to survey as a representative montane forest. The inventory, carried out between 12th-25th August, involved measuring trees (height and diameter at breast height) within a designated tract. See www.fao.org/3/a-ae578e.pdf for methodological details. The data will go towards an estimation of carbon sequestration by Ngel Nyaki forest.

Following the survey, Ngel Nyaki featured again in the National workshop on validation of the National Forest Reference Emission Level (FREL) for Nigeria. Held in Abuja, all the 36 State Directors of Forestry attended. Dr Danladi Umar represented the NMFP as a major stakeholder, and reported on how the importance of Ngel Nyaki was emphasised to all attendees by Prof. Akindele in his presentation.

Lightning strike research

Drs Tim Hill and Lucy Rowland (U Exeter), Prof. Manu Haddad (U Cardiff) and Dr Ed Mitchard (Edinburgh U).

Last year we reported on the setting up of the National Environment Research Council, UK funded investigation into the effect of lightning strikes on tree death in tropical forests. Over 10,000 trees within the Ngel Nyaki CTFS plot have now been fitted with collars designed to 'trip' when a lightning strike runs down the tree. The collars were successfully transported by air from Cardiff and amazingly! arrived on Mambilla in early February 2018.

As we go to press (January 2019) I can report the first detection of a lightning strike that has passed through a tree; "a fuse has been burned (it is really melted) in Ngel Nyaki (Nigeria) and the sensor is damaged by the lightning force" (Silveo Stiivanello- technical officer on the project).

A huge 'thank you' to the NMFP field staff for this result. In combination with Tim Hill's determination to have the logistics work and Silveo's technical expertise and rapport with the field assistants, the work has continued beyond all odds. Remember- it was Silveo who had to be evacuated in March.

Ali Abdul working on the coils used in the investigation of the influence of lightning strikes on tree death. The field assistants have done a huge job of making thousands of coils, placing them round trees and observing each coil after lightening. They have thoroughly enjoyed this interaction with Silveo Stivanello, the technical officer associated with the Exeter project.

Mammal Inventory

The NMFP employed Lydia Nyam Ajiji and assistant Tayo to carry out a mammal inventory for Ngel Nyaki. The pair arrived in late October and spent two weeks using a combination of camera trap, spoor and droppings data to assess the mammals in and around Ngel Nyaki forest. They recorded 24 mammal species, with some additional duikers, squirrel and rat species still being identified. Next year's Annual Report will feature the full report.

Godson and Lydia during the mammal survey.

New research linkage

In April I visited Professor's Colin Chapman in Uganda to discuss postgraduate research possibilities for students interested in working with the NMFP but whom we cannot accept at the moment. PhD students looking for tropical research in primatology, seed dispersal and similar projects, may enrol at UC and work in Kibale National Park in Uganda. Such projects will be a collaboration with myself and Professor Colin Chapman. Please visit chapmancolin.com for more details of Kibale research.

Community involvement

Nursery School

The NMFP continue to support the nursery school we built, we do this in many ways and combine this with the conservation club. All IT students teach at the school.

This year Misa was successful with his grant proposal to the TY Danjuma Foundation for assistance with building maintenance and teaching supplies for the nursery school. Many congratulations to Misa, he was successful with this grant because of his proven abilities and good character. From this grant three school buildings were renovated and the students received personal learning aides (top) as well as numerous school resources.

The teachers also benefited from training courses, covered in the grant.

The school renovations were documented on Taraba State Television and in a Taraba Radio broadcast.

L-R: Useni Tukura (Taraba State Television); Misa, Henry Agby (Taraba Radio Cooperation); Akila R. Ayuka (Taraba State Universal Basic Education Board, TSUBEB)

Misa talking to the Yelwa Community Elders about the school upgrade and how it will benefit their community.

The Yelwa football team volunteers helping with the planting of seedlings into the grassland.

Football Club volunteers

The Yelwa football club continue to assist the project when more hands are needed. Here they are helping plant tree seedlings back into regeneration sites after the fires. The seedlings were grown in the nursery and mainly comprise fire sensitive species.

The club also regularly assist in fire tracing and also in the building of fences round the regeneration plots. In return, I have promised All Black shirts for the team.

Beyond Bees

We are still looking at ways of developing a honey business for Yelwa and surrounding villages. There is huge potential but we need funding. Our Board Member John Adeleke has championed this initiative.

Ridwan Jafar attended the ApiExpo Africa in Abuja – 25–29th September "Beekeeping Industry for Sustainable Development, Wealth Creation and Economic Diversification" to represent the NMFP and the Beyond Bees initiative. Ridwan made several valuable contacts and learnt much about the bee keeping community in Nigeria. Several well- qualified and experienced bee keepers have offered their services to us, and we are currently applying for funding.

If anyone reading this is interested in helping the project develop a business plan / proposal for funding, please contact us.

Conservation Club

We actively engage with students of all ages through our conservation club. Our aim is that the children of Yelwa associate the NMFP with a good place to be. On their frequent visits we show movies in the new science outreach centre, provide coke etc. and generally give the children a good time. Of course this all revolves around talking about the significance of the forest, the ecosystem services it provides and how forest helps to mitigate climate change

Outputs

Peer reviewed articles

Chu, C., Lutz, J., Král, K., Vrška, T., Yin, X., Myers, J., ... Hubbell, S. (2018). Direct and indirect effects of climate on richness drive the latitudinal diversity gradient in forest trees. Ecology Letters, 21. doi:10.1111/ele.13175

Arroyo, D., Hale, M., Blackburn, D., & Chapman, H. M. (2018). Conservation genetics of two threatened frogs from the Mambilla highlands, Nigeria. PLoS ONE.

Adewoye, R., & Chapman, H. M. (2018). Mapping deforestation patterns with time series MODIS data and BFAST algorithm. Journal of forest research and management, 15(1), 22–35.

Yadok, B. G., Gerhard, D., Forget, P. -M., & Chapman, H. M. (2018). Size doesn't matter: Larger *Carapa* seeds are not dispersed farther by African rodent community. African Journal of Ecology, 56.

Umar, D. M., Harding, J. S., & Chapman, H. M. (2018). Food Web Structure in Tropical Highland Stream Ecosystem. Greener Journal of Biological Sciences, 8(3), 29-41. Retrieved from www.gjournals.org/GJBS/archive/vol-8-3-july-2018.html

Osinubi, S., Brown, J., Briskie, J., & Chapman, H. (2018). Carotenoid-based plumage pigmentation and concentration as a function of sex and habitat type in the Yellow-breasted Boubou *Laniarius atroflavus*. Ostrich: Journal of African Ornithology, 49(2).

Aliyu, B., Thia, J., Moltchanova, E., Forget, P. -M., & Chapman, H. M. (2018). Forest disturbance and seasonal food availability influence a conditional seed dispersal mutualism. Biotropica, 50(3), 1–8. doi:10.1111/btp.12570

Adewoye, R., & Chapman, H. M. (2018). Testing spectral variation hypothesis on the Afromontane forest ecosystem of Ngel Nyaki, north eastern Nigeria with landsat 8 (oli) and macro-ecological data. Journal of Forestry Research and Management, 15(1), 145–161.

Umar, D. M., Harding, J. S., & Chapman, H. M. (2017). Response of benthic invertebrate communities to a land use gradient in tropical highland streams in Nigeria. Tropical Freshwater Biology, 26, 53–77. Retrieved from www.ajol.info/index.php/tfb

Mahmoud, M. I., Sloan, S., Campbell, M. J., Imong, I., Alamgir, I., Chapman, H. M., ... Laurance, W. F. (2017). Alternative Routes for a Proposed Nigerian Superhighway to Limit Damage to Rare Ecosystems and Wildlife. TROPICAL CONSERVATION SCIENCE, 10, 1–10. doi:10.1177/1940082917709274

Umar, D., Harding, J. S., & Chapman, H. (2017). Riparian land use and the relationship between invertebrate communities and litter decomposition in a tropical highland stream. Nigeria Journal of Fisheries, 14, 1093–1107.

Walters, M., Knight, A., Chapman, H. M., Kraberger, S., Stainton, D., Varsani, A., ... Christopher, A. (2017). Novel single-stranded DNA virus genomes recovered from chimpanzee feces sampled from the Mambilla Plateau in Nigeria. American Society for Microbiology, 5(9), e01715-e01716. doi:10.1128/genomeA.01715-16

Under review

Nsor C, Godsoe, W, Chapman HM A tree visitation network only remotely resembles a pollination network for Afromontane sunbirds. Acta oecologia

Charles, L., Dwyer, J., Yadok, B., Chapman, H. Landscape position and woody vegetation within the matrix mediates seed dispersal under isolated pasture trees across distinct tropical regions. (Journal of Biogeography-17-0606).

Other publications

Yadok, B., Jafar, R., & Chapman, H. M. (2018). Does seasonal aridity and fruit availability affect the fate of seeds removed by scatterhoarding rodents in montane forests of Nigeria?. In F. babiola (Ed.), Proceedings of 6th NSCB Biodiversity Conference; Uniuyo 2018 (255 - 260pp) Vol. 6 (pp. 255–260). Uyo, Nigeria: Worldpress.

Roselli, S., Jafar, R., & Chapman, H. M. (2018). Influence of Post-Dispersal Seed Predation on Forest Regeneration in A West African Montane Landscape. In F. Babiola (Ed.), Proceedings of 6th NSCB Biodiversity Conference Vol. 6 (pp. 273–278). Uyo, Nigeria.

Umar, D., Chapman, H. M., & Harding, J. (2018). Food Web Structure in Tropical Highland Stream Ecosystem. In F. Babiola (Ed.), Proceedings of 6th NSCB Biodiversity Conference Vol. 6 (pp. 261–267). Uyo.

Conference Talks

Yadok, B., Gerhard, D., Pech, R., & Chapman, H. M. (2018). Density, population size and activity periods of African giant pouched rats (*Cricetomys* sp. Nov) in a West African montane forest landscape. In Australian Society for the Study of Animal Behaviour. Brisbane.

Abiem, I., Dickie, I., & Chapman, H. M. (2018). Is regeneration in tropical Afromontane forests declining? An assessment of seed rain and seedling composition and diversity in a Nigerian Montane environment. In Association of Tropical Biology and Conservation. Kuching, Sarwak.

Abiem, I. (2018) Does neighbourhood crowding drive seedling survival in Afromontane forests? University of Canterbury 2018 Annual Biology Conference (ABC) October 2018.

Chapman, H. M., Lawes, M., Dutton, P., & Hutchinson, K. (2018). Are puttynose monkeys saving the day? Little evidence for surrogate dispersal in a West African montane Landscape. In Association for Tropical Biology and Conservation. Kuching.

Tela, M., Cresswell, W., & Chapman, H. M. (2018). Are birds providing ecosystem services to subsistence farmers in West African montane landscapes?. In Association of Tropical Biology and Conservation. Kuching, Malaysia.

Tela, M. The value of forest fragments in maintaining ecosystem services for subsistence farming in West-African Montane forest. University of Canterbury 2018 Annual Biology Conference (ABC) October 2018.

Brailsford, L., Chapman, H. M., & Hale, M. (2017). Evidence for reduced genetic diversity within two common Afromontane tree species with contrasting dispersal mechanisms. In NZ Molecular Ecology Conference. Otago.

Tela, M., Chapman, H. M., & Cresswell, W. (2016). The Impact of Plantation Crop

Production Systems on Bird Species Diversity and Abundance on a Nigerian Farm. In Pan-African ornithological conference (PAOC). Dakar.

Yadok, B., Jafar, R., & Chapman, H. M. (2018). Does seasonal aridity and fruit availability affect the fate of seeds removed by scatterhoarding rodents in montane forests of Nigeria?. 6th NSCB Biodiversity Conference; Uniuyo 2018 Uyo, Nigeria.

Roselli, S., Jafar, R., & Chapman, H. M. (2018). Influence of Post-Dispersal Seed Predation on Forest Regeneration in A West African Montane Landscape. 6th NSCB Biodiversity Conference. Uyo, Nigeria.

Umar, D., Chapman, H. M., & Harding, J. (2018). Food Web Structure in Tropical Highland Stream Ecosystem. 6th NSCB Biodiversity Conference. Uyo.

Biodiversity Conservation Conference

Dr. Danladi Umar presented an address on behalf of Hazel Chapman at 6th Biodiversity Conservation Conference in University of Uyo, Akwa-Ibom State, Nigeria. The Nigerian Montane Forest Project contributed to sponsorship of the conference and our team presented four research talks.

ForestGEO Analytical Workshop

In July 2018 Iveren Abiem, our plot manager, attended the 2018 ForestGEO Analytical Workshop in Bruno, the Czech Republic.

This was a valuable experience for Iveren; it provided her with an opportunity to discuss her data analysis with experts in the field. These data are part of Iveren's PhD thesis and link in with her report, see page 15.

Dr Danladi Umar addressing the conference.

Dr Danladi Umar (right) with Dr Fola Babalola (centre).

Iveren with the participants of the ForestGEO Analytical Workshop in Bruno, Czech Republic.

Our conservation research is ongoing...

Adams Hassan replacing old phenology tags. We have two thousand tagged trees which are recorded on a monthly basis for flowering, fruiting, new leaf and flower buds since 2005.

Augustine Ntim making notes on the seedling establishment of seeds planted in the nursery. The aim is to transfer seedlings into grassland to help regenerate forest.

The plant checklist continues to grow. This Clerodendron is an new record for Ngel Nyaki. See the full checklist at www.canterbury.ac.nz/afromontane/flora/

A new species of Anthonotha? Similar to A. noldae, this leguminous tree species has smaller flowers and pods.

Lichen drying in the sun in a compound of one of the communities bordering the reserve.

Sacks of lichen, collected from within Ngel Nyaki reserve. The lichen is sent to Lagos for sale in markets.

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