

Hongera Mpala!

Science & Outreach Report



MPALA

**MPALA RESEARCH CENTRE &
MPALA WILDLIFE FOUNDATION**



Hongera* Mpala!

*** Hongera is a Swahili word meaning congratulations**



TABLE OF CONTENTS

- 5 **Director's Letter**
- 6 **About Mpala**
- 7 **Partners**
- 8 **Mpala at 25**
- 10 **Faces of Mpala**
- 12 **25 Years of Rain & Drought**
- 14 **Education at Mpala**
- 16 **A Mission to Wipe Out Rabies**
- 19 **Community Stories**
- 20 **Building Community**
- 22 **Conservation Highlights**
- 24 **The Great Grevy's Rally**
- 25 **Elephant Interventions**
- 26 **Science in Action**
- 29 **A Legacy of Research**
- 30 **2018 Running Publications List**
- 32 **MpalaLive!**
- 33 **Looking Ahead**



DIRECTOR'S LETTER



Celebrating 25 Years of Exploration and Discovery at Mpala

Mukenya Hill sits squarely in the middle of Mpala and offers a broad, sweeping view over the magnificent landscape of Central Laikipia. The harsh, rugged country and stillness of the earth below has offered numerous students and scientists a glimpse of life and time unfolding. Of the many beautiful places on Mpala, this one is without a doubt one of my favourites.

On a clear day one can look at both Mt Kenya and the Aberdares, the details of vegetation zones and stream-cut valleys etched out. Herds of animals, both wild and tame, plod along below, with delighted families of elephants frolicking in the dams during the heat of the day. Cheerful swifts slice through the cool air, and later on sombre Verraux's Eagles rise on powerful thermals. Rare butterflies gather to engage in hill-topping displays of territorial vanity. From here, one can even look 'down' at ambling herds of giraffes!

Standing on Mukenya, one looks onto a world undergoing dramatic changes, that also offers glimpses into the very beginnings of the earth. The rocks of Mukenya are indeed ancient. Part of the Pre-Cambrian basement, that stretches back into deep time over 4 billion years ago! More recently (well in geological terms) as the tectonic forces began pulling Africa apart forming the Great Rift, these ancient rocks were exposed and lifted into the thin, crisp air of the Laikipia Plateau.

How many people and creatures have visited this spot over the ages?

Over a million years ago, our hominid ancestors also stood atop this place. They would have seen many similar and a few different animals, sought refuge from storms and rampaging predators, and hunted, foraged and fished. Today, we have evidence of their time on Mpala through the vast array of stone tools left behind that have survived through millennia. It is humbling to think that we are relative latecomers to this view.

And over the past 1000 years, the drama of recent human history has played out with Proto-Cushitic peoples and hunter-gatherers giving way to pastoralists, then came ranching, with boundaries changing over time, and today, a rich mosaic of land use and land tenure and diverse people are in place, with thriving wildlife and Mother Nature continuing her evolutionary dance. Rivers rising and falling, rain and drought cycling, and our insatiable curiosity driving us to explore this wild and beautiful place.

It is truly incredible that for over two decades, Mpala has now served formally as a place for science, as a dynamic 'living laboratory'.

As a place for us to ask questions about the natural world and to seek answers through discovery and lucky encounters, exquisitely complex experiments, and diligent, intensive measuring and observing of everything from ants to elephants, genes to trees, individual atoms to entire ecosystems. Most importantly this is accomplished by bringing young, curious minds to bear on the deep mysteries of our world.

Everyday at Mpala I am inspired by how our curiosity for understanding the world around us brings students and scientists from near and far alike to spend time here.

All of this is made possible by our incredible staff, supporters, partners, students and scientists.

Let us all join together in celebrating this milestone.

Hongera Mpala!

Dino J. Martins

Science | Education | Conservation

ABOUT MPALA

The **Mpala Research Centre** was opened in November 1994 at the core of the Ewaso Ecosystem, a large, geographically diverse region of central Kenya, defined by the Ewaso Ng'iro River and its tributaries. The region is characterised by arid- and semi-arid savannas and woodlands and has an estimated 100 mammal and 550 bird species, including large populations of elephants and rare species like the Grevy's Zebra, Reticulated Giraffe, African Wild Dog and Black Rhino. The region is unique in that little of it is formally protected, yet wildlife abundance rivals the renowned Maasai Mara and Serengeti Ecosystems. The Mpala property is located on the Laikipia Plateau and has grown to be over 48,000 acres. It is a hub for experimental and manipulative research by visiting scientists and students. Mpala provides a 'living laboratory' without the restrictions of a national park, allowing scientists to manipulate the environment and conduct landscape level, controlled experiments to explore basic science, address real-world problems, and ensure that sustainable livelihoods and economic advancement are synonymous with wildlife conservation.

Mpala's Institutional Mission is to support research that improves ecosystem functions, conserves biodiversity and enhances the livelihoods of employees and their families who are predominantly traditional pastoralists. In conjunction with this mission, Mpala works to advance the understanding and conservation of natural and human-occupied ecosystems through basic research, education, outreach, and by creating new scientific knowledge and developing science-based solutions to guide conservation actions for the benefit of nature and human welfare.

MPALA'S OBJECTIVES:

- Operate an enduring facility for research and education in environmental, biological, and conservation sciences at local, national, and international levels.
- Sustain a long-term environmental monitoring program, to measure changes in climate, land use, vegetation, livestock and wildlife numbers, to understand biotic processes at the landscape level, and to identify mechanisms for maintaining the integrity of an expansive savanna ecosystem.
- Develop an informed approach to conserving the natural resources of the greater Ewaso ecosystem, and, by example, other 'non-protected' areas of Kenya.
- Promote human and wildlife co-existence in the greater Ewaso ecosystem and provide information to help resolve conflicts.
- Provide educational opportunities via experiential learning in research and monitoring skills for students and professionals from Kenya and around the world.

SCIENCE



EDUCATION



CONSERVATION



PARTNERS

Mpala is a joint venture of the Mpala Wildlife Foundation, Princeton University, the Smithsonian Institution, the Kenya Wildlife Service, and the National Museums of Kenya. Mpala provides interdisciplinary research and training programs in ecology, evolution, geology and resource management to scientists from Kenya and around the world. Researchers representing all our partners, are drawn to Mpala to study the centre's remarkable ecosystems making Mpala a hub for collaborative research.



In 1989 George Small created the **Mpala Wildlife Foundation** to fund the activities necessary to achieve his vision. It supports the wildlife conservancy, a primary school for employee's children, community outreach, including a Mobile Clinic, as well as the working cattle ranch that successfully coexists with an abundance of wildlife.



Princeton University serves as the managing partner for Mpala. Through Princeton University, Mpala has been awarded several NSF grants to improve facilities and completely rebuild the campsite and most recently to construct a cutting-edge genomics and stable isotope laboratory. Throughout the year, Princeton faculty, researchers, graduate and undergraduate students visit the property to expand their knowledge of the African landscape and to undertake research.



The **Smithsonian Institution** is a Trust Instrumentality of the United States that administers a group of Museums and Research Centres. Mpala is the Smithsonian Institution's first permanent research facility in Africa. The Smithsonian Institution offers multiple fellowship opportunities with Mpala to promote the study of biology, anthropology, geology, hydrology, material science, social science, soil science and related areas. The Smithsonian also collaborates with Mpala on long-term research and monitoring on the greater Ewaso ecosystem.



The **Kenya Wildlife Service** is the government agency tasked to protect and manage the fauna, flora and ecosystems of Kenya. KWS undertakes and coordinates biodiversity research and monitoring. Multiple research projects collaborate with the KWS when scheduling collaring of wildlife. More recently, the Smithsonian-Mpala Veterinary Fellow has been working with KWS veterinarians to treat injured or sick wildlife on Mpala and surrounding conservancies.



The **National Museums of Kenya** is a state organisation that manages museums, sites and monuments in Kenya. It carries out heritage research, and has expertise in subjects ranging from paleontology, ethnography and biodiversity research and conservation. Multiple researchers at Mpala are officially affiliated with NMK and collaborate with NMK scientists, making extensive use of their facilities, materials, and expertise.

MPALA TURNS 25!

A quarter of a century ago George Small and a small group of his friends had the improbable idea to create a space for scientific exploration and discovery in the middle of the wild, windswept Laikipia Plateau. Thanks to the vision and passion of the early boards of trustees, support and collaboration between the Mpala Wildlife Foundation, Princeton University, the Smithsonian Institution, the Kenya Wildlife Service and National Museums of Kenya, and the incredible hard work and dedication of staff, students and scientists alike over the years, today Mpala is a thriving hub for science, education and conservation.

Over the past 25 years, students and scientists from all over the world have benefited from the intricate encyclopaedia of life that can be read here. Their data and discoveries have been distilled into hundreds of research papers.

Lessons from these have gone to shape how we keep livestock, protect wildlife, treat diseases and engage in further exploration of nature in East Africa and around the world. The excitement of these new discoveries made on Mpala have been shared in by hundreds of millions of people and embedded this tiny, remote corner of northern Kenya firmly in the annals of scientific history.





- 1994** ● Mpala Research Trust is established
Mpala breaks ground
Nick Georgiadis becomes MRC Director
- 1995** ● Mpala received NGO status
Kenya Long-term Exclosure Experiment Project begins
- 1997** ● The McCormak Lab is constructed
- 1999** ● Jenga House is built
- 2002** ● The NSF Lab is constructed
- 2007** ● Margaret Kinnaird is hired as MRC Director
- 2008** ● The Northern Kenya Conservation Clubs is established
The Ewaso Ng'iro River Camp is built
- 2010** ● The Ungulate Herbivory Under Rainfall Uncertainty Project begins
The Hydroflux Tower is constructed
- 2011** ● ForestGEO plot measurements begin
Smithsonian House is built
- 2014** ● MpalaLive! webcam is erected
- 2015** ● Dino J. Martins is hired as Mpala Director
The Laikipia Rabies Vaccination Campaign kicks off
- 2016** ● The first Great Grevy's Rally
- 2017** ● Mpala Ranch and Mpala Research Centre start the process towards One Mpala
- 2019** ● Mpala turns 25!

FACES OF MPALA



Julius Nakolonyo makes everyone's life safer and is always happy to help.



Francis Pirozis, the most humble guy you will ever meet in your life.



Alick Roberts is a good Mzee who believes in fairness.



Beatrice Wanjohi is a stickler for protocol and the rules, but always with a twinkle in her eye.



No one is as sweet as **Elizabeth Kibatis**. You will always find a friend in her.



Quiet in speech but loud in laughter, **Fardosa Hassan** is kind, polite, honest and completely helpful.



John Githae is a warm and welcoming presence, who is passionate about his garden and sharing the fruits of his labour with those around him.





25 Years of Rain & Drought

1994 - 2019



> 800 MILLIMETERS



For the past 2 decades, only 4 years have received more than 800 mm total rainfall. The last year being 2011, which experienced the most rainfall ever at 1016.14 mm.



6 YEARS

6 out of the past 20 years saw less than 500 mm total rainfall, leading to severe drought in the region. Mpala is still recovering from last year's drought.

10.5 X RAINFALL



Historically, April receives 10.5X more rainfall than February. This year saw April receive the most rainfall ever and over 370X more than February.

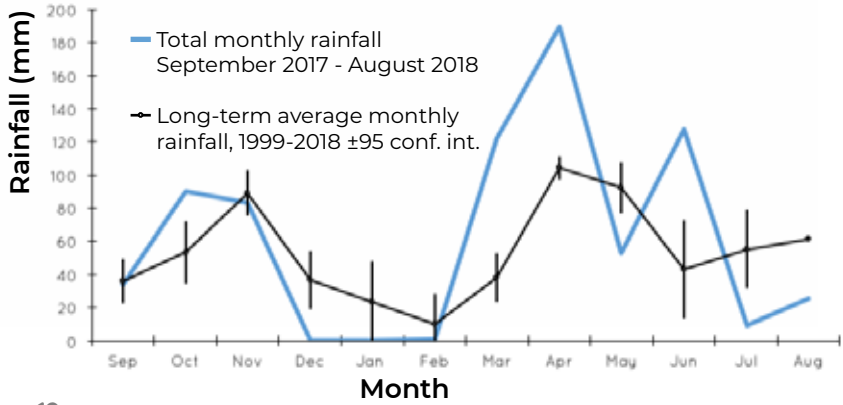


400% INCREASE

2017 was a year of severe drought at Mpala. This year, 2018, there was a 400% increase in the amount of rain experienced in March to July, compared to last year.

Source: Caylor K.K., Gitonga, J., Martins, D.J. (2018) Mpala Research Centre Meteorological and Hydrological Dataset. Laikipia, Kenya: Mpala Research Centre.

Mpala Rainfall
September 2017 - August 2018



2017 VS 2018



EDUCATION AT MPALA

Mpala facilitates excellent educational opportunities for scholars from Laikipia, Kenya and from around the world. The vast array of internships and fellowships that are offered allow for students and recent graduates to pursue their passion in a hands-on learning environment where they can explore new ideas and research topics. Mpala also facilitates education by offering scholarships for Mpala Academy students and students in nearby communities. In the past few years, Mpala has supported several students pursuing their education, both at high school and at college.

Mpala helps students financially, assisting in their education, and provides mentoring from researchers and administrative staff. Mpala also promotes educational opportunities by hosting field courses and workshops. Students and professionals that come through Mpala for these experiences, walk away having gained a unique insight into human-wildlife interactions, the savanna ecosystem and more. Mpala takes pride in supporting and encouraging educational opportunities for a wide range of students. It is a core part of our mission and will be expanded on in the coming years, offering more scholarships, hosting more fellowships and facilitating more courses.

Fellowships at Mpala allow for recent-graduates, masters, doctoral students and postdoctoral researchers to dive into ground-breaking research and do rigorous science. Over the years, the capacity for fellowships has increased and now Mpala hosts 7 fellows and offers more funding for fellows to conduct their own research projects.



DR DUNCAN KIMUYU

Dr Kimuyu is a lecturer at Karatina University and received the Smithsonian Mpala Postdoctoral Fellowship to study mammalian herbivores' abundance and browsing within the Mpala CTFs-ForestGEO plot. Dr Kimuyu has been studying interactions between fire and herbivory, by both domestic and wild ungulates, in the Kenya Long-term Exclosure Experiment (KLEE Project) at Mpala Research Centre. His research has opened up new ways of thinking about livestock, wildlife, and fire management in savannas.



DR SARA WEINSTEIN

Dr Weinstein received the Smithsonian Mpala Postdoctoral Fellowship to study toxin resistance in the African crested rat (*Lophiomys imhausi*). Her research focuses on studying host-parasite-poison interactions. Her study species, the only known lethally toxic mammal, defends itself against predators using plant-derived cardenolides, the same toxins used as traditional arrow poisons.



DR MAUREEN KAMAU

Dr Kamau is Mpala's very first Smithsonian One Health Veterinarian Fellow, in conjunction with the Smithsonian Global Health Program. Her most recent project makes use of camels as a surveillance tool for sympatric wildlife species in Laikipia. When Dr Kamau is not studying camels, she can also be found attending to the wildlife around Mpala, earlier this year she successfully treated a 2 month old elephant calf with a snare on its left forelimb.



30 Interns

Interns from around the world were hosted at Mpala and each tackled unique projects and gained professional skills along the way.



5 New Internships

2 new teaching internship spots were added through Princeton University, while 3 research interns from Pembroke College joined Mpala.



33% Kenyans

A third of this year's interns were Kenyan. The UHURU Project interns were graduates of Daraja Academy. While 21% of workshop participants were Kenyan.



309 Participants

Workshop participants come from Kenya and around the world to gain hands-on research experience and to learn about the unique savanna ecosystem and human-wildlife interactions.



8 Workshops

Workshops covered topics such as GIS mapping and One Health through the Smithsonian; and livestock, wildlife and public health, led by Dr. and Mrs Cooper.



19 Courses

Mpala has hosted multiple field and educational courses. Students go on game drives, attend lectures from Mpala's researchers and go into the field to explore the savanna.

A MISSION TO WIPE OUT RABIES

By Dedan Ngatia, Co-founder, Laikipia Rabies Vaccination Campaign

Photos By: Paula Kahumbu, WildlifeDirect, CEO



Rabies is a viral disease that is almost always fatal in humans following the onset of symptoms. About 2,000 people die of rabies annually in Kenya. More than 98% of the country's human rabies cases result from bites by infected domestic dogs.

Mass canine rabies vaccination is a cost-effective means of reducing human rabies cases in developing countries. Moreover, immunising dogs against the disease may also reduce transmission to other domestic and wild mammals who can also succumb to rabies (such as cows, black-backed jackals, hyenas, and endangered African wild dogs).

The **Laikipia Rabies Vaccination Campaign** is a mass canine rabies vaccination effort that primarily targets remote rural areas in the county, where human vaccines may not be available or accessible and where people – particularly children under 15 years – are at greater risk of dying from rabies compared to other populations. Conceived by Mpala researchers, Dedan Ngatia and Dr Adam Ferguson, and Dr Dishon Muloi, a veterinarian

from the International Livestock Research Institute, the LRVC started as a localised effort in 2015 and since then has expanded to over 50 communities.

The team has recently partnered with and received support from numerous individuals and organisations, including the Laikipia County Government, Laikipia Wildlife Forum (LWF), Kenya Wildlife Service and Veterinarians International. The campaign relies on volunteers including veterinarians, Karatina University students, and Mpala staff and continues to partner with the NKCC to promote rabies education in local schools.

This year's Laikipia Rabies Vaccination Campaign is scheduled for October-November 2018 with a target of vaccinating over 10,000 dogs! This will be the first year that we'll be using microchips, providing us with a better tracking and measurement system. Every year the campaign evolves, the system of vaccinating dogs gets more efficient and the bites from dogs decreases.





COMMUNITY STORIES



Caroline recently graduated from Amboseli Institute of Hospitality and Technology with a degree in Tourism Management. She previously attended Daraja Academy. This is her perspective of her internship experience this past summer.

CAROLINE MASAKWI: INTERN WITH UHURU PROJECT

Working at Mpala has been one of the most exciting times since finishing my university degree in Tourism management. After applying, I got a chance to work with the Research Centre. Coming to Mpala has been a really great working experience and allowed me to work closely with experts in their fields. Being a tourism student, most of my lectures and experiences focused on working closely with the environment and wildlife, but this internship allowed me to explore different avenues. I spent time both in and out of the field, identifying tree species and collecting samples while also doing extensive data entry. It was a truly wonderful experience! School allowed me to develop skills in taxonomic identification, but this opportunity allowed me to further expand myself, especially in tree identification.

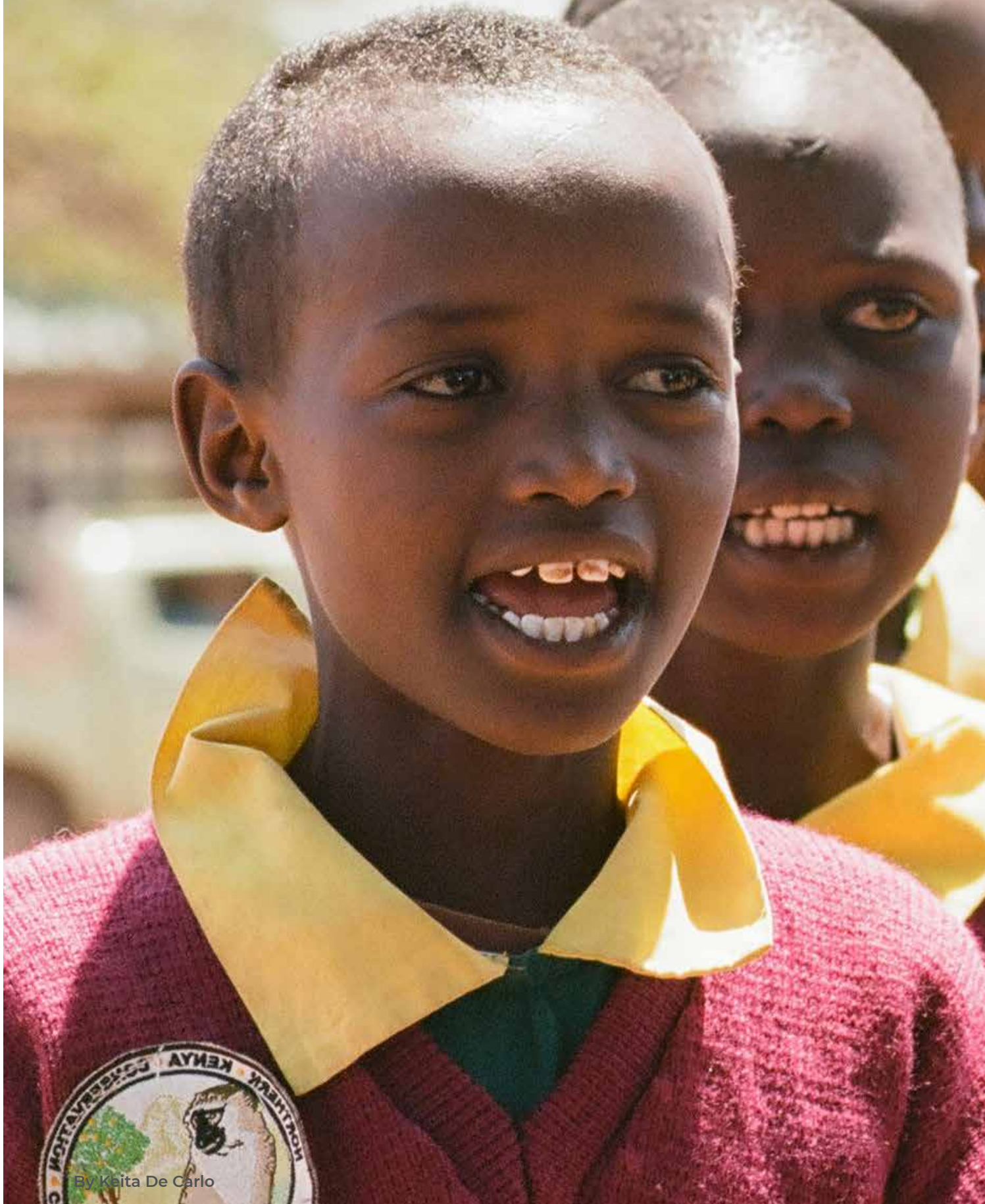
The most memorable part of this internship was being able to go out in the field with specialists like Tosca, Sam, Ali, Ekeno, Buas and Peter, who helped us collect shrubs and grass and who later helped us with the lab analyses. Working with these experts was such a pleasure! I learned how to identify over 20 different tree species, and added those to my running college list. I would really love to work with them again so I can continue to learn how to identify trees, herbs, shrubs, and grass and increase my confidence in identifying them by their appearance, leaves, barks and scent. To Mpala & Rob Pringle, I am very grateful for this opportunity and for enriching my passion for trees. This has been a memorable working experience and I will be forever grateful for this opportunity.





BUILDING COMMUNITY

Mpala is an active part of its community and over the past 25 years has developed partnerships with surrounding conservancies, schools and neighbours.



By Keita De Carlo

CONSERVATION THROUGH EDUCATION

By Nancy & Dan Rubenstein, Co-founders, NKCC & EveryIn Ndinda, Clubs Supervisor, NKCC

The **Northern Kenya Conservation Clubs** were started as an outgrowth of Dan Rubenstein's research on Grevy's Zebra in Samburu. Dan and his team hired three scouts in each community to collect data. Every year Dan and his colleagues would go to the communities to share what was learned from the data, going afterwards into the local primary school to teach a lesson on conservation biology. One of the head teachers asked Dan how the lessons could continue when he wasn't there. Thus the idea of the conservation clubs was conceived. Dan and his wife Nancy, a teacher, held a workshop with local teachers and members of each group ranch to determine what the curriculum should include. In 2009, the first year, there were clubs in four primary schools: Mpala, Il Motiok, Naiperere, and Ewaso. They were selected because these were schools in the communities where Dan was then conducting research. There are now 14 clubs in 12 primary schools and two secondary schools covering over 30 square kilometers.



Dan & Nancy Rubenstein at the 2018 Community Conservation Day.

The clubs meet one day a week after school, during the school terms. The goal is to raise students' awareness of the natural world around them and the need to take care of the land and wildlife. To make the lessons memorable and different from the rest of the school day, the activities are very much hands-on and include games that teach concepts, original drawing and writing by students, exploration of the natural world, as well as reading stories about concepts included in the curriculum. Because the learning is fun and different, students go home and talk to their families about what they learned in conservation club, thus sharing the learning.

On a Saturday in July every year, a Community Conservation Day is held at the most centrally located school. All the clubs attend, and the community is invited. It's a day of learning and sharing. There is an environmental fair, in which every club presents a display about a conservation project at their school or a topic they've been learning about. Each club makes a presentation – a poem, play or activity that they've worked on. Over 400 students attend, and it's a fun day for all.

Because this style of teaching is so different from what our club teachers are used to, a teacher workshop is held every January to help teachers understand what experiential (hands-on) learning is and how to carry out the activities. Most importantly, the teachers also take the role of students to see what makes the activities fun.

Since the beginning of the conservation clubs, Wilson Nderitu, head field assistant at Mpala, has also been the club coordinator, getting to the clubs when he's available, teaching, meeting with teachers, distributing materials, etc. For the past two years the clubs also have had two Kenyan supervisors who are able to get out to the clubs more regularly to help keep the lessons and activities going.

Achievements of the conservation clubs this year include:

- All of the clubs visited Mpala, Ol Lentille, Ol Jogi or Loisaba Conservancies this year and were inspired by the conservation projects they saw and learned about.
- Through our discussions this year, we are planning to increase evaluation processes to understand the impact of conservation education in our communities.
- Wilson and his wife, Evelyn, one of our club supervisors, have instituted conservation lessons and activities during the school holidays for students.
- Students in the Mpala and Shiloh Naibor clubs have been working on biocontrol efforts of the invasive plant *Opuntia*.

CONSERVATION HIGHLIGHTS



CITIZEN SCIENTISTS PARTICIPATE IN THE 2ND GREAT GREVY'S RALLY

By Dedan Ngatia

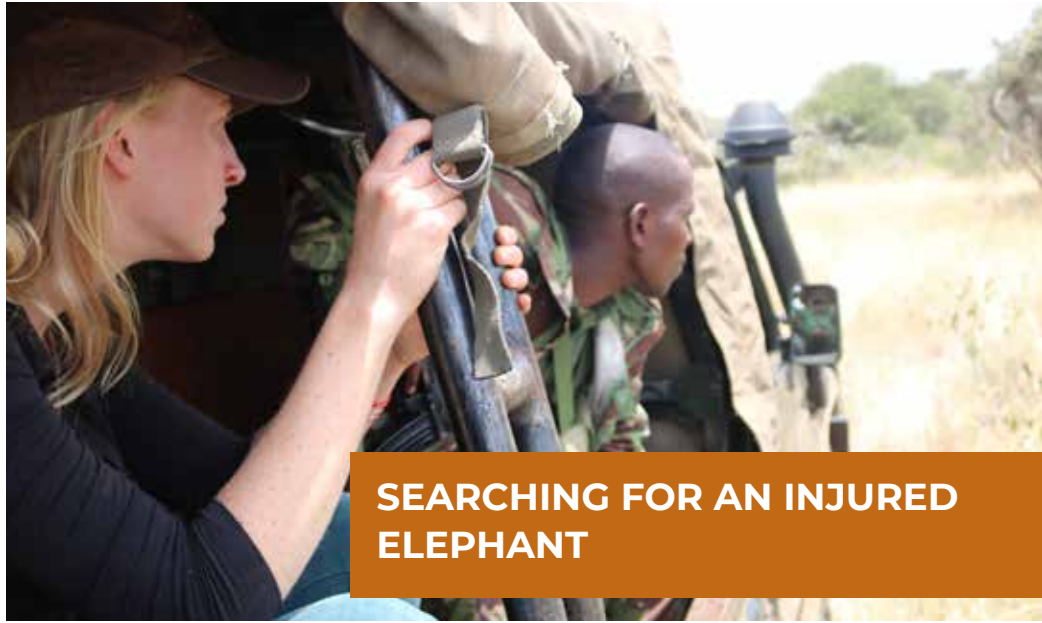


COLLARED AFRICAN WILD DOGS AS PART OF THE KENYA RANGELANDS WILD DOG & CHEETAH PROJECT



A MPALA ACADEMY STUDENT SPREADING A BIOCONTROL, THE COCHINEAL INSECT, ONTO THE INVASIVE OPUNTIA PLANT





SEARCHING FOR AN INJURED ELEPHANT



DR DOMINIC MIJELE OF KWS ATTENDS TO A YOUNG BULL ELEPHANT WITH A BROKEN LEG

THE GREAT GREVY'S RALLY

By Zoe Sims, Former Princeton in Africa Fellow, Mpala Research Centre



How many Grevy's Zebra remain in Kenya? Where do they live? And what is their population structure? In January 2018, hundreds of citizen scientists came together to help researchers answer exactly these questions.

Over two sunny late-January days, at least 700 people, including 212 armed with digital cameras, collected more than 49,000 photos of Grevy's Zebras and Reticulated Giraffes as they traversed the animals' range in Laikipia, Samburu, Meru, Isiolo and Marsabit counties. After the Rally, a computer program scanned these images to detect the distinctive stripes of a Grevy's Zebra or the tiles of a Reticulated Giraffe. This information was then analyzed, databased, and compared to determine the identity of each photographed individual.

The 2018, Mpala partnered with GGR to create the largest citizen science effort ever undertaken in Kenya, bringing together conservancy members, county officials, the Kenya Wildlife Service, and citizen scientists from across Kenya and around the world. The project grew out of the Mpala-based Grevy's Zebra Project, which has studied the population, dynamics, and behaviour of the endangered species for the last decade. The Grevy's Project research contributed to the development of Wildbook, a technology that

can "read" the unique stripes of a zebra or the patches of a giraffe, just like fingerprints, to distinguish between individuals. This technology empowers anyone with a camera to contribute to understanding the species and its conservation.

Thousands of photos were synthesised into an updated estimate of the Grevy's Zebra population size and status: there are just over 2,800 Grevy's Zebra in northern Kenya, reflecting a significant increase compared to the 2016 estimate. The final results of the Rally provide key insights into the species' current status, population structure, and distribution after the past two years of drought and conflict in the region. The Rally's ultimate aim is that this information will inform the species' conservation, while, at the same time, the experience of participating in the scientific process and interacting with the species in their natural habitats will empower and engage citizens and youth in the conservation of these unique and threatened species.

Mpala and the Great Grevy's Rally team look forward to welcoming even more participants in 2020 to count what we hope will be even larger populations of Grevy's Zebras and Reticulated Giraffes!

ELEPHANT INTERVENTIONS

By Dr Maureen Kamau, Mpala-Smithsonian Veterinary Fellow, Mpala Research Centre



As a wildlife veterinarian, when an elephant injury is reported, the next step is always to determine whether the elephant is in a family group and to ascertain the age of the injured elephant. The purpose of this is to create a mental note on how long and intense the intervention might take.

On the 23rd of July, around 6 pm it was reported that there was a very young elephant calf with a snare on its left forelimb. The snare was tightly entangled around the elephant's left forelimb. Due to impending nightfall the security team was advised to monitor the elephant family and report on their location the following day. By the time the Kenya Wildlife Service, Mt Kenya Region Mobile Veterinary Unit arrived, the elephant family had already crossed the Ewaso Ng'iro river into the neighbouring Ranch.

Elephants are very intellectual. They seemed instinctively aware of the advantage they had over us preferring to remain hidden in the bushy and rocky areas with the elephant calf barely visible as it laced between the other herd members' legs. After trailing the elephant herd for about 2 hours, the calf's mother was successfully darted by a quick shot as it vanished into the bush again. After ensuring that the elephant cow was anesthetically stable, another dart was prepared for use on the elusive calf. By this time the sun was close to the horizon, only allowing us about 30 minutes. Soon enough darkness set in and we had to yield until next time.

Unfortunately, the elephants had had it with us, only to be spotted again 2 weeks later on the 8th of August at Mpala. This time the wire snare had savagely cut into the little elephant calf's left wrist leaving it lame and unable to keep up with the rest of the herd. It was decided by Dr Mathew Mutinda to immobilise both the calf and its mother. Again the elephants did not disappoint in their display of their close family bond and intelligence. They were more aggressive, making apprehensive sounds, flaring their ears and making attempts to charge at us.

Once both animals went down and the area was secured, the wire snare was removed and the wound cleaned and bandaged, including supportive therapy with painkillers and antibiotics administered. In just 8 minutes it was already time to pack up and awaken both elephants. The rest of the family herd was already encroaching by the time they came to.

The elephant calf was spotted three weeks later with notable dramatic improvement, healed with a slight limp, but thriving.

Wildlife veterinary interventions are riddled with loads of anxiety, adrenalin and uncertainties. A lot of team effort goes into any successful intervention. It is these humbling successful events that constantly remind us of how resilient wildlife and nature is; and of our noble duty to allow it to flourish for our future generations.

SCIENCE IN ACTION



By Ray Schmidt



By Azwad Iqbal



By Elizabeth Forbes



By Joanna Zhang



By Nicholas Harvey

Mpala was established as a working cattle ranch, which makes it uniquely valuable to land use and land cover research. Most wildlife scientists in Africa do their fieldwork in officially protected national parks and reserves. Yet most of the wildlife lives outside the parks. With human populations surging and animal habitats shrinking, Mpala acts as a living laboratory to test the ways that humans, livestock and wildlife can coexist.

Throughout the year, faculty, researchers as well as graduate and undergraduate students from all across the world visit the property to expand their knowledge of the African landscape and to undertake research involving both human and wildlife populations, land use, the hydrological cycle and intersecting dynamics, such as humans-wildlife conflict.

Currently, there are over 30 projects ongoing at Mpala, involving around 150 scientists and students. Of particular importance are those funded by the National Science Foundation (NSF). In the last five years Mpala has hosted 14 NSF grants initiated within the past 5 years. In addition, Mpala has previously received two NSF facilities improvement grants. Mpala is currently hosting many of the National Geographic Grants in East Africa and most of the Nature Conservancy NatureNet Fellows in Africa. From 1995 to 1999 (the first 5 year of Mpala), only 17 papers were published in peer-reviewed journals from research conducted at Mpala. This year alone, 44 papers have already been published. Highlights from this year include the establishment of a cutting-edge endocrinology laboratory by Chester Zoo and the University of Manchester to aid conservation efforts of the endangered Eastern Black Rhino and Grevy's Zebra; the expansion of the Smithsonian's Global Health Program at Mpala; Princeton University brought over 8 senior thesis students who conducted independent research ranging from the ecology of the elusive leopard tortoise and the intersection between pastoralism and ecotourism to how animal movement affects the landscape.



By Shailee Shah



By Patrick Milligan



By Leo Malinatti



By Elizabeth Forbes

A LEGACY OF RESEARCH

KENYA LONG-TERM ENCLOSURE EXPERIMENT (KLEE)

DR TRUMAN YOUNG (U.C. DAVIS), DR DUNCAN KIMUYU (KARATINA UNIVERSITY), DR WILFRED ODADI (EGERTON UNIVERSITY), DR CORINNA RIGINOS (THE NATURE CONSERVANCY), DR KARI VELEN (UTAH STATE UNIVERSITY)

The Kenya Long-term Enclosure Experiment (KLEE) was established in 1995 to determine the separate and combined effects on savanna ecology of herbivory by cattle, elephants, and other wildlife species, as well as fire. KLEE consists of 18 large (ten acre) experimental plots that can be viewed as representing a) different land uses (management for cattle, wildlife, or both) or b) the sequential loss of large wild herbivores. In addition to the plots themselves, the KLEE project has engaged in research on pastoral boma footprints and an audacious tree-thinning experiment. The overall project has thus far generated nearly 120 peer-reviewed publications, with over 80 from the enclosures, making KLEE the most scientifically productive field experiment ever carried out on the African continent. The KLEE plots have promoted collaborations among scientists from across the globe, producing cutting edge research and additional embedded experiments. These studies have been highly influential identifying the myriad ways that ecological communities are structured and function, and in particular how such insights can inform management and conservation actions.

PRINCETON ZEBRA PROJECT

DR DANIEL RUBENSTEIN (PRINCETON)

Before the Mpala Research Centre came into existence, Rubenstein studied both plains and Grevy's zebras in Samburu and plains zebras in Tanzania's Ngorongoro Crater. Those projects revealed much about their social and behavioural intricacies. With the creation of Mpala, long-term data of known individuals of both species enabled the project to construct genetic pedigrees and social networks that are mined to explore the ways in which kinship and social relationships are affected by environmental conditions and shape decision-making. Since its inception, over 65 papers have been published on zebras. Some have been on zebra themselves and their social lives, but others have used insights from this knowledge to inform management and conservation strategy. Initial work on zebra-livestock mutualisms has blossomed into exploring how further rangeland benefits can accrue by tinkering with livestock rearing practices. Similarly, an understanding of movements and needs is required to develop strategies for conserving the endangered Grevy's zebras. This project tracks Grevy's zebra numbers, their movement patterns, and health, while having a large outreach and education component and using research-based solutions to minimise human-wildlife conflict. Over the next 25 years the project will expand to look more closely at diets, disease and interactions with other grazers, especially livestock.

UNGULATE HERBIVORY UNDER RAINFALL UNCERTAINTY (UHURU)

DR ROBERT PRINGLE (PRINCETON), DR JACOB GOHEEN (U. WYOMING), DR TODD PALMER (U. FLORIDA)

African savannas and their large mammals are iconic, but many fundamental questions about how the mammals shape the landscape, and vice versa, remain unanswered. These questions are timely because large-mammal populations are also declining worldwide, with major shifts in the balance of many ecosystems expected. Established in 2008, UHURU seeks to address these questions. UHURU, like its predecessor KLEE, uses large-scale plots and electric fences to simulate size-based mammal extinctions but is distributed across a rainfall gradient. It is the combination of these two distinct features that distinguishes UHURU from prior experiments. A decade on, the 36 plots are permanent installments on the Mpala landscape, enabling researchers to tease apart how the strength and direction of herbivores' effects depend on climate; similarly, to assess the impacts of droughts and other environmental fluctuations, and will most likely remain for a decade more. Through the collaboration of multiple studies, we have learned, among other things, that herbivores of different sizes occupy different roles for controlling invasive shrubs and that climatic stress mediates the strength of herbivore impacts on plant populations. To date, 20 papers have been published in peer-reviewed journals.

FORESTGEO

DR DAVID KENFACK (SMITHSONIAN TROPICAL RESEARCH INSTITUTE) & DR PAUL MUSILI (NATIONAL MUSEUMS OF KENYA)

The first Forest Global Earth Observatory (ForestGEO) plot was established in 1980 on Barro Colorado Island, Panama. Over the years, the ForestGEO program has expanded from wet to dry tropics and into temperate areas. In 2009, Mpala became the 41st site chosen to be part of ForestGEO. Currently, ForestGEO spans 26 countries, focused on understanding the development and maintenance of biodiversity and our ability to evaluate and respond to the impacts of global climate change. With the establishment of the Mpala Plot, the ForestGEO program is making its first foray into savanna ecosystems. The Mpala plot is unique in other ways. At 150 ha, it is the largest ForestGEO plot (most are 50 ha or less), and it is floristically simple (only 7 tree species were identified in the first five months whereas other ForestGEO plots can hold up to 450 species). The impacts of land-use and climate change are predicted to have a profound effect on the ecosystem and the biodiversity at Mpala. The plot has already provided both short- and long-term data on the dynamics of the vegetation of an ecosystem which undergoes grazing by both livestock and wildlife. This year began the second survey of the plot!

CURRENT PUBLICATIONS LIST 2018

- Amornbunchornvej, C., Brugere, I., Strandburg-Peshkin, A., Farine, D., Crofoot, M., & Berger-Wolf, T. (2018). Coordination Event Detection and Initiator Identification in Time Series Data. *ACM Transactions On Knowledge Discovery from Data*, 12(5), 1-33. doi: 10.1145/3201406
- Bergstrom, B.J., R.L. Sensenig, D.J. Augustine & T.P. Young. 2018. Searching for cover: soil enrichment and herbivore exclusion, not fire, enhance African savanna small-mammal abundance. *Ecosphere* 9:e02519.
- Bidner, L.R, Matsumoto-Oda, A., & Isbell, L.A. (2018). The role of sleeping sites in the predator-prey dynamics of leopards and olive baboons. *American Journal of Primatology*, 80(12), e22932.
- Boyle, J. H., Martins, D. J., Pelaez, J., Musili, P. M., Kibet, S., Ndung'u, S. K., Kenfack, D., & Pierce, N. E. (2018). Polygyny does not explain the superior competitive ability of dominant ant associates in the African ant-plant, *Acacia* (*Vachellia*) *drepanolobium*. *Ecology & Evolution* 8:1441-1450.
- Buck, J.C. and S.E. Perkins. 2018. Study scale determines whether wildlife loss protects against or promotes tick-borne disease. *Proc. R. Soc. B* 285: 20180218.
- Cabal, C., & Rubenstein, D. I. (2018). Above- and below-ground allocation and functional trait response to soil water inputs and drying rates of two common savanna grasses. *Journal of Arid Environments*, 157, 1-12.
- Costelloe, B.R. & Rubenstein, D.I. (2018). Temporal structuring of vigilance behaviour by female Thomson's gazelles with hidden fawns. *Animal Behaviour*. 145, 87-97.
- Coverdale, T. C., Goheen, J. R., Palmer, T. M., & Pringle, R. M. (2018). Good neighbors make good defenses: Associational refuges reduce defense investment in african savanna plants. *Ecology*, 99(8), 1724-1736.
- Davis, G. H., Crofoot, M. C., & Farine, D. R. (2018). Estimating the robustness and uncertainty of animal social networks using different observational methods. *Animal Behaviour*, 141, 29-44.
- Dudenhoeffer, M., & Hodge, A. C. (2018). Opposing forces of seed dispersal and seed predation by mammals for an invasive cactus in central kenya. *African Journal of Ecology*, 56(2), 179-184.
- Goheen, J. R., Augustine, D. J., Veblen, K. E., Kimuyu, D. M., Palmer, T. M., Porensky, L. M., ... Young, T. P. (2018). Conservation lessons from large-mammal manipulations in east african savannas: The KLEE, UHURU, and GLADE experiments. *Annals of the New York Academy of Sciences*.
- González, J. B., Pepitas, R. H., Franken, O., Kiers, E. T., Veblen, K. E., & Brody, A. K. (2018) Herbivore removal reduces influence of arbuscular mycorrhizal fungi on plant growth and tolerance in an East African savanna. *Oecologia*, 1-11.
- Guindre-Parker, S., & Rubenstein, D. R. (2018b). The oxidative costs of parental care in cooperative and pair-breeding African starlings. *Oecologia*, 188(1), 53-63.
- Henry, L., Tokita, C., Misra, M., Forrow, A., & Rubenstein, D. (2018). Mutualistic acacia ants exhibit reduced aggression and more frequent off-tree movements near termite mounds. *Biotropica*, 50(4), 559-562. doi: 10.1111/btp.12572
- Isbell, L. A., Bidnerac, L. R., Van Cleave, E. K., Matsumoto-Oda, A., & Crofoot, M. C. (2018). GPS-identified vulnerabilities of savannah-woodland primates to leopard predation and their implications for early hominins. *Journal of Human Evolution*, 118, 1-13.
- Iwata, M., Matsumoto-Oda, A. Otaki, J. M. (2018). Rearing the African Grass Blue Butterfly *Zizeeria knysna*: Toward the Establishment of a Bioindicator in African Countries. *African Study Monographs*, 39(2), 69-81
- Keesing, F., Ostfeld, R. S., Young, T. P., & Allan, B. F. (2018). Cattle and rainfall affect tick abundance in central Kenya. *Parasitology*, 145(3), 345-354.
- Keesing, F., R.S. Ostfeld, S. Okanga, S. Hockett, B.R. Bayles, R. Chaplin-Kramer, L.P. Fredericks, T. Hedlund, V. Kowal, H. Tallis, C.M. Warui, S.A. Wood & B.F. Allan. 2018. Consequences of integrating livestock and wildlife in an African savanna. *Nature Sustainability* 1:566-573.
- Kerr, M., Rosario, K., Baker, C. C. M., & Breitbart, M. (2018). Discovery of four novel circular single-stranded DNA viruses in fungus-farming termites. *Genome Announcements*, 6(17)
- Kinga, G. W., Mironga, J., & Odadi, W.O. (2018). Analysis of the spatial relationship between cattle and wild ungulates across different land-use systems in a tropical savanna landscape. *International Journal of Ecology*, 2018, 2072617.
- Louthan, A. M., Pringle, R. M., Goheen, J. R., Palmer, T. M., Morris, W. F., & Doak, D. F. (2018). Aridity weakens population-level effects of multiple species interactions on *Hibiscus meyeri*. *PNAS*, 115(3), 543-548.
- Lutz, J. A., Furniss, T. J., Johnson, D. J., Davies, S. J., Allen, D., Alonso, A., ... Kerckhoff, A. (2018). Global importance of large-diameter trees. *Global Ecology and Biogeography*, 27(7), 849-864.

Matsumoto-Oda, A., Okamoto, K., Takahasi, K., & Ohira, H. (2018). Group size effects on inter-blink interval as an indicator of antipredator vigilance in wild baboons. *Scientific Reports*, 8(1), 1-9.

McCauley, D. J., Graham, S. I., Dawson, T. E., Power, M. E., Ogada, M., Nyingi, W. D., . . . Brashares, J. S. (2018). Diverse effects of the common hippopotamus on plant communities and soil chemistry. *Oecologia*, 1-15.

Mutinda, M. Crofoot, M.C., Kishbaugh, J.C., Hayek, L.C., Zimmerman, D., Tunseth, D.A., & Murray, S. (2018). Blood biochemical reference intervals of free-ranging olive baboons (*papio Anubis*) in Kenya. *International Journal of Primatology*, 1. doi: 10.1007/s10764-018-0074-2

O'Brien, T. G., Kinnaird, M. F., Ekwanga, S., Wilmers, C., Williams, T., Oriol-Cotterill, A., . . . Frank, L. G. (2018). Resolving a conservation dilemma: Vulnerable lions eating endangered zebras. *PLoS One*, 13(8), e0201983.

Odadi, W. O., Riginos, C., & Rubenstein, D. I. (2018). Tightly bunched herding improves cattle performance in african savanna rangeland. *Rangeland Ecology & Management*, 71(4), 481-491.

Odadi, W.O. 2018. Using heart girth to estimate live weight of heifers (*Bos indicus*) in pastoral rangelands of northern Kenya. *Livestock Research for Rural Development* 30:16.

Odadi, W.O., G.K. Charles & T.P. Young. 2018. Cattle preferentially forage on African savanna termite mounds, but not when they share habitat with wild ungulates. *Ecology & Evolution* 71:281-291.

Parham, J., Stewart, C., Crall, J., Rubenstein, D.I., Holmberg, J., & Berger-Wolf, T. (2018). Focusing animal identification with annotations of interest. 2018 IEEE Winter Conference on Applications of Computer Vision (WACV), 1075-1083.

Pikus, A. E., Guindre-Parker, S., & Rubenstein, D. R. (2018). Testosterone, social status and parental care in a cooperatively breeding bird. *Hormones and Behavior*, 97, 85-93.

Prior, K. M. & Palmer, T. M. (2018). Economy of scale: third partner strengthens a keystone ant-plant mutualism. *Ecology*, 99, 335–346.

Riginos, C., Porensky, L. M., Veblen, K. E., & Young, T. P. (2018). Herbivory and drought generate short-term stochasticity and long-term stability in a savanna understory community. *Ecological Applications*, 28(2), 323-335.

Rosario, K., K.A. Mettel, B.E. Benner, R. Johnson, C. Scott, S.Z. Yusseff-Vanegas, C.C.M. Baker, D.L. Cassill, C. Storer, A. Varsani & M. Breitbart. 2018. Virus discovery in all three major lineages of terrestrial arthropods highlights the diversity of single-stranded DNA viruses associated with invertebrates. *PeerJ* 6:e5761.

Ruiz-Guajardo, J. C., Schnabel, A., McCallum, B., Arnaiz, A. O., Baldock, K. C. R., Stone, G. N. (2018). Differences in pollination syndromes and the frequency of autonomous delayed selfing between co-flowering *Hibiscus aponeurus* (Sprague and Hutch) and *H. flavifolius* (Ulbr) from Kenya. *Journal of Pollination Ecology*, 22(3), 21-34.

Schuttler, S.G., R.S. Sears, I. Orendain, R. Khot, D. Rubenstein, N. Rubenstein, R.R. Dunn, E. Baird, K. Kandros, T. O'Brien, & R. Kays. 2018. Citizen science in schools: students collect valuable mammal data for science, conservation, and community engagement. *Bioscience* 69(1), 69-79.

Sitters, J., & Olde Venterink, H. (2018). A stoichiometric perspective of the effect of herbivore dung on ecosystem functioning. *Ecology and Evolution*, 8, 1043–1046.

Stears, K. and D.J. McCauley. 2018. Hippopotamus dung inputs accelerate fish predation by terrestrial consumers. *African Journal of Ecology* 56:1034-1038.

Stears, K., D.J. McCauley, J.C. Finlay, J. Mpemba, I.T. Warrington, B.M. Mutayoba, M.E. Powers, T.E. Dawson, and J.S. Brashares. 2018. Effects of the hippopotamus on the chemistry and ecology of a changing watershed. *PNAS* 115:E5028-E5037.

Taniguchi, H., & Matsumoto-Oda, A., (2018). Wound healing in wild male baboons: Estimating healing time from wounds size. *PLoS ONE*, 13(10), e0205017.

Titcomb, G., R.M. Pringle, T. Palmer, & H.S. Young 2018. What explains tick proliferation following large-herbivore exclusion? *Proceedings of the Royal Society B: Biological Sciences* 285(1878):20180612

Tucker, M.A., Böhning-Gaese, K., Fagan, W.F., Fryxell, J.M., Moorter, B., Rubenstein, D.I. et al. (2018). Moving in the Anthropocene: global reductions in terrestrial mammalian movements. *Science*. 359 (6374), 466-469.

Van Cleave, E. K., Bidner, L. R., Ford, A. T., Caillaud, D., Wilmers, C. C., & Isbell, L. A. (2018). Diel patterns of movement activity and habitat use by leopards (*panthera pardus pardus*) living in a human-dominated landscape in central kenya. *Biological Conservation*, 226, 224-237.

Young, T. P., Riginos, C., Veblen, K. E., Odadi, W. O., Kimuyu, D., Porensky, L. M., Young, H., & Charles, G. K. (2018). Relationships between cattle and biodiversity in a multi-use landscape revealed by the Kenya Long-term Exclosure Experiment (KLEE). *Rangeland Ecology and Management*. 71(3), 281-291.

MPALALIVE!

MpalaLive! excites and educates viewers about the extraordinary wildlife that graces our landscape; showcases the research and work done at the Mpala Research Centre; and inspires a new generation of conservation biologists. It has been an extraordinary year for the MpalaLive! program. In June we celebrated the fourth anniversary of the launch of the live cams and the **mpalalive.org** website & in July we hosted Dr Jane Goodall for a live interview with Executive Director, Dino J. Martins.



45 Million Views

Lifetime views of the live cams on all platforms (YouTube, Facebook Live, Explore.org) top 45 million with about 1.5 million hours of viewing on YouTube alone.



88 Species

The Interactive Field Guide features 88 species (possibly the most complete resource for East African animals available online).



25 Live Chats

MpalaLive! showcases 25 live chats and short videos describing the research and wildlife of Mpala (includes Lions, People, and Prey, a Webby honoree).



65% Visitors

65% of visitors check out the Classroom Section featuring downloadable lesson plans and classroom activities geared to US and Kenyan students from grades 1 through 12.



LOOKING AHEAD

Looking forward to the next 25 years of science, education and conservation at Mpala, we truly stand at a point in time where we can more robustly use our knowledge to help solve the many challenges we face. The passion for discovery and knowledge that each and every student and scientist brings to Mpala is something that we need to continue to harness to help answer some of the big questions facing humanity, and especially the people, wildlife and landscape of Laikipia.



In 25 years Kenya's population, currently growing at over 1 million people annually, will be close to 100 million people, while our earth will be home to close to over 9 billion people. This growth raises huge challenges around the sustainable use of natural resources and the drylands, rivers and wildlife of Mpala are in many ways at the cutting edge of these issues in Kenya. From water to energy, to wildlife and food production in the face of climate change, these are all questions that we start to help answer through science. By bringing the brilliance, curiosity and sheer hard work of students and scientists to bear on these issues, we can come up with solutions.

New technologies are an essential part of doing science and expanding the horizons of knowledge, Therefore, Mpala is investing in creating spaces, support and skills to enable students and scientists to make use of these technologies in genetics, genomics, stable isotopes, GIS and Big Data on-site at Mpala. With data flowing out from this hub to the rest of the world, the ability to track, understand and respond to issues in real time will be possible.

Building a sustainable future is something that Mpala is looking forward to for the next 25 years. Engaging in a robust co-production of the knowledge underlying this, and empowering and engaging scientists, students and communities more broadly and inclusively is one of our guiding principles.

We look forward to the next 25 years of science and discovery at Mpala.

NEW CUTTING-EDGE GENOMICS & STABLE ISOTOPE LABORATORY



PARTNERS

BORANA
CONSERVANCY

CETRAD
Center for Tropical Environmental and Societal Studies

CHESTER ZOO

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

The Cornell Lab
of Ornithology

Daraja

GEORGE MASON UNIVERSITY

GREVY'S ZEBRA TRUST



Image-Based Ecological Information System
IBEIS

icipe



KENYA WILDLIFE SERVICE

Lakipia Wildlife Forum
"CONSERVATION IN ACTION"



UNIVERSITY OF LEEDS

LEWA WILDLIFE CONSERVANCY
A UNESCO World Heritage Site Inscribed in 2010

LOISABA CONSERVANCY - LAIKIPIA

Marwell Wildlife

Defining Conservation
Key: Maria Perle for Ornithology
University of Toronto, Ontario



NATIONAL GEOGRAPHIC

NATIONAL MUSEUMS OF KENYA
WHERE HERITAGE LIVES ON



The Nature Conservancy

NatureKenya

NRT
NORTHERN RANGELANDS TRUST

OL JOGI LIMITED

OL PEJETA CONSERVANCY



UNIVERSITY OF OXFORD

PEMBROKE COLLEGE OXFORD

PEI
PRINCETON ENVIRONMENTAL INSTITUTE



SAC ZOO

Saint Louis Zoo
Animals Always

SAN DIEGO ZOO GLOBAL

Segera

SPACE FOR GIANTS
Building a World for Large Mammals in the 21st Century

ST LAWRENCE UNIVERSITY

TURKANA BASIN INSTITUTE

UC DAVIS

UC Santa Barbara

MANCHESTER 1824
The University of Manchester

University of Nairobi

UNIVERSITY OF WYOMING

USAID
FROM THE AMERICAN PEOPLE

VETERINARIANS INTERNATIONAL

WILDLIFE DIRECT

Yale University

ZSL
LIVING CONSERVATION

ZDU REPUBLIC OF KENYA ZOOLOGICAL DISEASE UNIT

Founder

George Small (1921-2002)

Board of Directors: Mpala Research Centre

Aly Kassam-Remtulla (Chair), *Princeton University*

Daniel Rubenstein, *Princeton University*

Geoffrey Mwachala (Secretary & Scientific Advisory Committee Chair), *National Museums of Kenya*

Kitili Mbathi (Finance Committee Chair)

Laurel Harvey (Treasurer), *Princeton University*

Patrick Omondi, *Kenya Wildlife Services*

Scott Miller (Vice-Chair), *Smithsonian Institution*

Dino J. Martins (Ex-Officio), *Executive Director*

Board of Directors: Mpala Wildlife Foundation

Dennis Keller (Chair)

Bill Walton

Don Graham (Emeritus)

Ira Rubinoff

Jeffrey Gonya

John Wreford-Smith

Laurel Harvey

Senior Management

Dino J. Martins, *Executive Director*

Alick Roberts, *General Manager*

Beatrice Wanjohi, *Head of HR & Administration*

Gikenye Chege, *Chief Finance & Operations Manager*

David Hewett, *Ranch Manager*



MPALA

Science • Education • Conservation

P.O. Box 555 - 10400,
Nanyuki, Kenya
Tel: +254 2025 97401

info@mpala.org

www.mpala.org

© 2018 Mpala Research Centre



Design & layout by Ciara Nutter & Victor Kasii.

Front cover photo by Will Sims. Back cover by Victor Scharnhorst. Science photo on page 6 by Charlotte Christensen. Unless credited, photos are produced by Mpala Research Centre. All partner logos used with permission.