Conservation - Community - Research

Mpala Memos

news from Mpala

Top Story

The Feathered Faithful

Margaret Kinnaird

Nick hops onto the breakfast table, cocks his head and gives me a beady one-eyed stare before greeting me with a repetitive 'tok, tok, tok'. His mate, Lips, drops in from a nearby acacia and perches lightly on my shoulder. Both are addicted to a morning supplement of raw peanuts – and I admit, I have done nothing to discourage their habit. Having a wild creature throw all cares to the wind and trust me enough to pluck a peanut from my fingers makes for the best moments of my day.

Nick and Lips enjoy their favorite meal - raw peanuts. Photo by Nick Georgiadis.

Nick and Lips are a mated pair of Von der Decken's hornbills. Nick is a classic adult male with sleek black wings and tail feathers offset by a clean white belly and pantaloons. He anounces his gender through the orange and yellow colors of his long, decurved bill. Lips is clad in the same pied feather combination as Nick but in comparison she is more delicate and her bill is shorter, thicker

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Conservancy News

Digging Out Dirty Dams

Theresa Laverty

As part of an effort to become more "green," Mike Littlewood, Mpala's Ranch and Conservancy Manager, is de-silting and repairing dams across Mpala. During the 2009 drought, the Ewaso Nyiro River and the Ngare Narok River, which mark Mpala's eastern and western borders respectively, both ceased to flow. Luckily, our borehole was able to sustain the needs of Mpala throughout most of the year, lasting beyond the end of the drought. However, there was no other water to rely upon. As ground water becomes less accessible and the rivers dry out, Mike notes the need to have a

Dams are important for livestock as well as wildlife like this elephant family. Photo by Alick Roberts.

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Every Day is an Adventure with Christopher Tenai

Theresa Laverty

It is just past 6:00 am and there is a clear view of Mt. Kenya. The sound of a Land Rover grows closer. The bright smile of Christopher Tenai warms up the cool morning. I jump in the car and we are off for a morning game drive. Before long, the sun is rising and we are venturing along the roads of Mpala that only Tenai seems to know. He pops his head out the window to check the direction of last night's animal tracks on the road. Shortly afterward, he points out cape buffalo in the bush – animals I would never have seen were it not for his expert eyes. Some mornings we find elephant families or a tower of giraffes, others we see "*mbogo mingi*" or many buffalo. Hyenas, jackals, wild dogs, and even lions and leopards are not a rare sighting for Tenai. He knows Mpala like the back of his hand and would not prefer it any other way.

Christopher Tenai out on a morning game drive. Photo by Theresa Laverty.

Christopher Tenai, more commonly known as Tenai, first came to Mpala in 1987. He began as a waiter for the ranch, but eventually became a ranch driver and also works as a guide and tracker when needed. He fondly looks back on the days when George Small was alive, as he always served as his waiter. In his years at Mpala, Tenai has made many friends with visitors, trustees, and staff alike.

Since he was a child, Tenai has been intrigued by wildlife. Before Mpala, Tenai worked in Kitale, (in western Kenya), as a hunting guide for ranch owner John Gilford Smith. Together they went on hunting trips across Kenya including places like Turkana and Borgoria.

According to Tenai, Mpala's vegetation has not changed much since 1987 but the wildlife has. For example, Tenai remembers seeing only one Grevy's zebra in his early days. In comparison, Mpala is home to over 150 Grevy's zebra today. As humans have become more tolerant of wildlife, Laikipia's wildlife populations have boomed. In particular, Tenai notes that today you can find many more elephants and gerenuk. Additionally, the animals are more habituated to human presence on ranches like Mpala.

Tenai's favorite part of his job is showing visitors animals across Mpala. He believes it is the "reason for [his] existence." You can always count on a memorable game drive with Tenai. Even if you miss the lions firsthand, Tenai has his video camcorder ready to show you his most recent sighting. Although he says he speaks little English, he gets his point across with few words and his enthusiasm fills in any gaps.

Thanks to Tenai many people have experienced the thrill of spotting the more elusive wildlife of Mpala. So when Tenai recommends going out before sunrise, don't hesitate. You never know if you will be the lucky person to see Tenai's favorite: "*simba mingi*," or many lions, on your morning adventure with one of Mpala's favorite guides! ▪

Haven't I seen (or heard) you before?

Sara Keen

Any visitor to Mpala can't help noticing the colorful Superb Starlings. Recognized by their striking green and blue coloring, these birds forage near (and in) the dining hall or visit their nests in trees surrounding the bandas. But wait, these birds are more interesting than you might think!

You will hear these birds making loud, repeated calls when flying over their territory, but did you know that starlings might use these calls to recognize one another? Based on experiments I conducted this summer, it seems that starlings know whether or not they are related just by listening to each other's calls.

Because starlings live in large social groups of up to 30 birds, it would be useful if they had a strategy for knowing who was in their group. I set out to test the idea that they use their calls for just that purpose.

Photos by Sara Keen.

I first collected recordings of calls from nine different starling groups. Although most of these calls sound the same to you and me, starlings are much better than humans at discerning small differences in calls. After collecting hundreds of call recordings, Wilson Ndiritu, Godfrey Manyaas, and I conducted two experiments. First, we played recorded calls to the same group of

starlings that had made them; for the other, we played recorded calls from one group to a different group. Then, while hidden behind clumps of acacias, we eagerly watched to see what would happen.

I was excited to see that, as I had suspected, the starlings reacted differently to the different calls. Upon hearing calls from their own group, starlings would remain still and sometimes call back or sing afterward. However, when the starlings heard calls from another group they usually stopped singing and flew away. In other words, starlings recognize one another simply by listening to each others' calls!

But this is just one piece of the puzzle. Our next step will be to find out whether starlings can use their calls to recognize their immediate relatives within their group. Only by continuing to study starlings can we fully answer questions about their complex social system.

Next time you hear a starling calling, listen closely. There may be more to that call than you realize! ▪

Check this out!

Please visit Mpala's new website www.crowdrise.com/mpala to learn more about the projects going on at Mpala and how you can help!

Our Wildlife

Jennifer Bahmeier

I came to Mpala from Denver Zoo armed with a bag of paint brushes and a plan to work with kids of the Mpala Conservation Club to create a mural on the Primary School wall. With the generous help of club leader Wilson Nderitu and Head Teacher John Maina, the project came together beautifully. The pictures tell the story…

I provided a start by sketching the shape of each animal on the wall while the kids watched. They also had lots of pictures of each animal for them to reference while painting.

I was amazed by their abilities, especially because some of the kids had never held a paintbrush before.

My favorite moment of the day came when I asked if they planned to finish painting the Grevy's zebra (the belly had no stripes). They were (correctly) insistent that of course they wouldn't, because Grevy's zebra are mostly white there! After two hours everyone sat down to admire their creation.

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Our Wildlife

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Each club member placed his or her handprint on the wall and agreed that "Our Wildlife" was the best title for the mural. It is my hope that the mural project was, and will continue to be, a new way that the kids can connect with their wildlife. ▪

All photos by Jennifer Bahmeier.

Mpala Memories, Part VII: Animal and plant changes over the years

Truman Young

Previous installments of this series have concentrated on the history of the people, facilities, and research on Mpala. But there have also been dramatic and subtle changes amongst the plants and animals since I first came to Mpala over 20 years ago.

Arrivals

In the 33 years that I have been working in Kenya, wild dogs have gone from being vermin targeted for extermination to icons of conservation. After an absence of many years, they returned to the Laikipia ecosystem in 2000 and Mpala in 2002, and are now being sighted regularly. The other arrival is more quirky: the crocodile that showed up in 2007 at the Hippo Pools. Gerenuk are now poised to become Mpala residents as well, as they are abundant just across the river on Ol Jogi and two small groups of three to seven have established themselves around Mukenya.

Gerenuk are now found on Mpala. Photo by Margaret Kinnaird.

Certain other species arrived after there were buildings at MRC. The house rat is one example, but there are also animals that are native to Kenya that you only see in and around human structures. The Speckled Pigeon, the Red-winged Starling, and the house gecko are examples of species that thrive at the Centre. Think about it: have you ever seen any of these animals in the bush? The Fan-tailed Raven, the Little Swifts, Striped Swallows and those darned bats were all present around Mpala, but have become locally more abundant around the MRC buildings. The bush squirrels have either increased, or just become more visible (and mischievous). A local group of vervet monkeys has also made the Center their home.

Disappearances

There are at least two species that were resident at Mpala in the early 1990s but now are gone. When Lynne Isbell began her patas monkey study, there was a small group that ranged between Nyumba Mbili on Segera and the Mpala black cotton. Around 1995, this group disappeared, perhaps merging with a group that ranged only on Segera. There are still occasional sightings of migrant males on Mpala. Well into the 1990s, there were a few reedbuck (probably mountain reedbuck) on the escarpment directly above the Centre, but these have not been seen in since 1997/8. Anne Powys reports a similar loss on Suyian (previously Pinguone). This loss is a mystery.

Increases and decreases

When Alan Smith (Smithsonian Institution) and I first visited Mpala in 1989, John Wreford-Smith (then ranch manager) knew that there were exactly seven Grevy's zebra on Mpala, and Mike Littlewood reports there were none in the early 1980s. They are one of several species that have greatly increased in the last 20 years. Others include lions, and of course, elephants. Mike Littlewood, Anne Powys and Monty Brown add Vulturine Guineafowl, Red-billed and Yellow-billed Hornbills to this list.

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Of mice and Mites

Hillary Young and Cara Brook

Lions, elephants, hippos… large mammals that contribute to the magic of Mpala. They are among the many reasons scientists and tourists from all over the world are drawn to the region. However, for communities that share the landscape with these big creatures, the magic quickly dissolves and resentment builds when homes and crops are destroyed, when their livestock must compete for food, and when human safety is threatened. We hope our research will dampen some of the negative feelings toward big mammals by demonstrating that they actually benefit local communities. Surprisingly, one of these benefits is lowering the risk of human diseases transported by rodents.

A spiny mouse.
Photo by Hillary Young.

Our project builds on years of research by others at Mpala who looked at the ecological effects of the loss of large mammals. Previous experiments have shown that the loss of large wildlife results in a doubling in the number of rodents and a corresponding boom in their fleas. The rodent explosion is probably due to less competition for food as the large herbivores disappear. Our project compares protected lands like Mpala Ranch that have an abundance of big mammals with community lands where these animals are often sparse.

A bush rat being combed for parasites.
Photo by Hillary Young.

At each site, we lay small box traps to capture rodents. Each newly captured rodent is tagged so we can recognize it and use this information to estimate abundance. We also comb each rodent for mites and fleas that might be living in its fur and take blood to check for disease. Because rodents are proven carriers of human disease, our data will tell us how the presence or absence of big mammals across different land uses affects human disease risk.

Infectious diseases are a leading killer of humans globally, and those carried by rodents pose significant health threats in East Africa. The roster of rodent-carried diseases includes bubonic plague, typhus, and Leishmanaisis – all of which appear to be on the increase. It is possible that the loss of large mammals and increasing rodent numbers are the two, related factors contributing to this increase.

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November Board Meeting

Margaret Kinnaird

Trustees of the Mpala Wildlife Foundation (MWF) and the Mpala Research Trust (MRT) gathered on Mpala in late November 2010 to hold their annual board meetings. As usual, the discussions ranged far and wide but the focus of the meetings centered on mission fulfillment. Trustees want to ensure that, as Mpala moves forward in the next five years, we are doing more to benefit the people of Kenya. With a special focus on our neighbors in Laikipia, we will emphasize sustainable use of land, water, and energy, and engage more closely with our partners in science and education.

Left to right: Gail Hanlon, Phil Hanlon, Ingrid Graham, Don Graham, Ellen Scavia, Don Scavia. Photo by Laurel Harvey.

One aspect of these discussions delved into the need to balance the mix of institution-driven and independent, university-based research and to increase our institutional research portfolio. The board decided that expanding our partnerships is a crucial step towards diversifying and sustaining an institution such as MRT.

We were lucky to be joined by University of Michigan's Provost and Executive Vice President for Academic Affairs, Dr. Phil Hanlon, and the Director of the Graham Sustainability Institute, Dr. Don Scavia, for the first day of the meetings. We had some very productive discussions and as a result the University of Michigan has joined the MRT core partnership. Through its School of Natural Resources and the Environment, Department of Evolutionary Ecology, and the Graham Environmental Sustainability Institute, the University of Michigan provides a highly complementary research agenda and one that dramatically expands Mpala's areas of expertise (such as engineering, arts and design and socio-economic studies).

Sundowners at the hippo pools. Photo by Theresa Laverty.

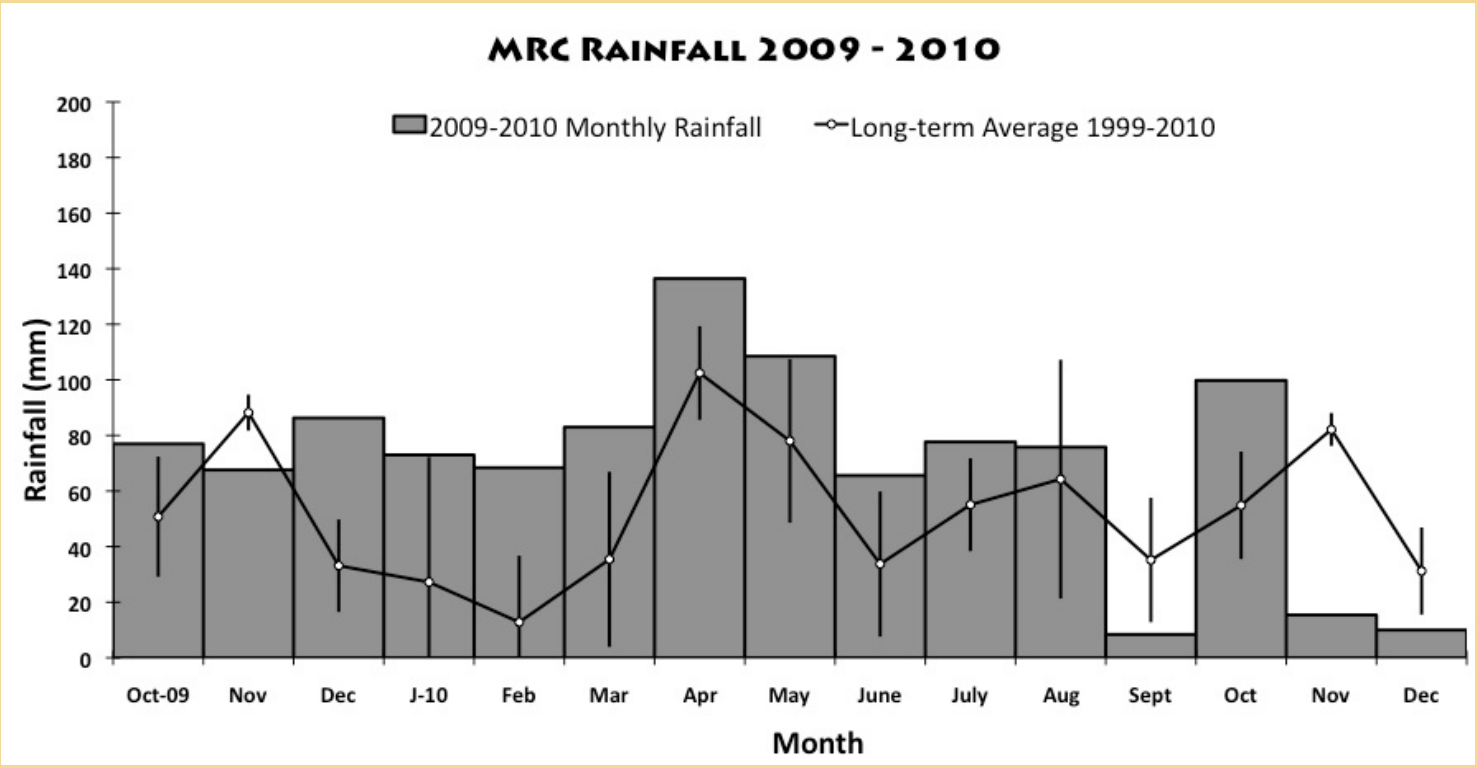
The university tested Mpala's waters in the summer of 2010 when it held an undergraduate course in ecology and supported a team of MSc students investigating ways for Mpala to become more water and energy efficient. The course was considered a success and the MSc project results have been extremely helpful for Mpala. The university is planning a follow up course and more projects for 2011. Mpala looks forward to deepening our relationship with the University of Michigan. ▪

So what's your New Year's resolution?

Margaret Kinnaird

For lots of folks, the answer to that question is "get more exercise!" That was never a possibility on Mpala, where a long walk or run across the savanna could mean dodging elephants or facing down an ornery buffalo – at least not until now. Thanks to a generous contribution from Dr. Frank Levinson, Mpala now has its own gym. The Levinson gym is well-kitted with an assortment of equipment to make your heart pound and muscles ache. But this is not your ordinary gym. An astronomer and physicist by training and philanthropist by heart, Frank is passionate about green construction. He insisted that the building be as much an experiment in green design as a functional gym. The new, half-walled structure has a big underground cistern for rainwater catchment and storage, solar powered electricity and hot water, low-flush toilets and low-use shower heads on timers. Over the summer, engineering students from University of Michigan and Princeton University will rig ways for gym - goers to produce energy or pump rainwater from the cistern as they exercise. So come burn some energy and help charge a phone or computer battery – there's no longer an excuse to get out-of-shape during a long Mpala field season. ■

Mpala Weather Corner



Mpala-at-a-Glance

Courses & Student Groups

• In mid-December, Tim O'Brien of WCS hosted a 2-day workshop on distance sampling and occupancy, which was attended by 22 participants affiliated with NMK, KWS, AWF, and Mpala.

• In January, 23 undergraduate students from Cornell University participated in a three-week behavioral ecology and conservation field course. The course was taught by Professor Irby Lovette of Cornell University.

Farewells and Welcomes

Mpala bids farewell to Darcy Ogada, the 2010 Smithsonian-Mpala Postdoctoral Fellow. Over the past year, Darcy studied the effects of vulture decline on mammalian scavenger populations and the consequent increased risk of disease transmission.

As we wish Darcy good luck in her future endeavors, we also welcome the 2011 Smithsonian-Mpala Postdoctoral Fellow, Hillary Young, who is studying how large mammal declines affect rodent populations and disease (see "Of Mice and Mites" on page 7).

2010: The Year in Review

2010 was our busiest year to date with a record occupancy of 11,654 bed nights at the research centre and campsite – up 21% from 2009. We hosted over 92 independent researchers representing 34 different institutions and organizations from around the world, and 190 students in groups from Hopewell Valley High School (NJ), McGill University, Cornell University, Leeds University, Kenyatta University, University of Illinois, University of Michigan, and Princeton University.

New Mpala Memos Head Editor

We would like to welcome Natasha Soderberg as our new Mpala Memos Head Editor. Natasha has worked in environmental education, development and administration for organizations such as the Jane Goodall Institute and Conservation international. Natasha will be replacing Corinna Riginos and Amy Wolf who helped initiate the Mpala Memos and kept it full of interesting contributions over the past two years. The Mpala Memos team extends warm thanks to Corinna and Amy and looks forward to their continuation as active members on the Memos team. ▪

Critter Corner

Of Mice and Mites

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Our initial work is showing that at least two common rodent-borne diseases are much more prevalent in sites lacking large wildlife. We are now expanding our trapping effort throughout Laikipia and into Northern Tanzania. Ultimately, we want to be able to predict disease risk across these regions based on patterns of human land use. We also hope that our results will provide one more compelling reason as to why land conservation is important and help ensure that the big, wild things of East Africa continue to exist. ▪

A small gerbil.
Photo by Hillary Young.

The Feathered Faithful

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and very black. Both derive their names from from bill peculiarities - Nick has a distinctive notch on top of his and Lips has unusual, red tips on her bill.

Apparently, these two have been an item for eight years or more. Last year, I was given a photo of two adult hornbills taken on my veranda in 2003. To my surprise, it shows Nick, with his characteristic bill divet, sidling up to a lovely female with distinctive red 'lips'. It takes at least two years for Von der Decken's to reach maturity and find a mate, so I figure my veranda pair are at least ten to eleven years old.

This year, Lips disappeared for a long three months. I feared the worst, but when she returned with a chick in tow, I realized she and Nick had taken advantage of the good rains to raise a family. Although she looked a little thin, Lips was sporting shiny new wing and tail feathers that she grew while nesting, after molting all her old scruffy ones. Being featherless would normally be a problem for a bird but like all hornbills, Lips settled into self-imposed imprisonment for egg-laying and chick-rearing and had no need to fly. Athough I never found her nest, Lips would have chosen a cosy tree cavity, then sealed the entrance, leaving only a narrow slit through which she, and later her chicks, received food deliveries from Nick. Although lots of other birds nest in holes, hornbills are the only birds in the world that use mud and feces to make a brick-hard seal over the cavity opening, leaving only a narrow window to the outside world.

There has been much speculation about why hornbills seal their nests. The obvious answer is that it helps protect the family from predators and other tree-hole dwellers that might want to usurp the nest site. But I think something much stronger drives female

Lips.
Photo by Nick Georgiadis.

hornbills to lock themselves in to a cramped living space for more than a month with screaming babies while waiting for her partner to bring food; mate control.

By enclosing herself, Lips demands Nick's dedication and forces a commitment from him to provide for his own offspring. He's simply too busy feeding his mate, his chicks and himself to find time for philandering. If he abandons or neglects his family, his chicks die and his reproductive investment for the year is lost – a big waste of time in the bird world.

Although 85% of bird species are considered monogamous (having only one mate), DNA testing is revealing that true monogamy is far less common than we thought. Not unlike the surreptitious affairs that occur among our own kind, a large proportion of so-called monogamous birds have been found to be unfaithful – some 12% of all chicks result from feathered affairs. Hornbills, however, are the outstanding exception; so far, DNA tests have failed to find one covert relationship.

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The Feathered Faithful

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Because of the good rains this year, Lips endured two rounds of self-imprisonment and and successfully pulled off two clutches of young. This has never been documented before for Von der Decken's hornbills. In keeping with my hypothesis, Nick was so busy running the provision service, he wouldn't even dally over morning peanuts. ■

Mpala Memories, Part VII: Animal and plant changes over the years

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When I first came to Laikipia, I wondered why warthogs were common at Sweetwaters and Ol Pejeta, but not at Mpala or Segera. I suspected that it was related to herders and their dogs, since I know that warthogs are hunted with dogs. It was not until Segera and Mpala banned herding dogs that this was confirmed. The rapid recovery of warthogs has been gratifying.

Meanwhile, Nick Georgiadis (past Director of Mpala Research Centre) has evidence for declines in hartebeest, eland, buffalo and waterbuck throughout Laikipia. On the plant side, *Acacia hockii* was once abundant in the area above Baboon Cliffs, but now are exceedingly rare. There have also been declines in the oldest fever trees (*A. xanthophloea*) and perhaps *A. tortilis*, which is at the upper limit of its distribution at Mpala.

Fluctuations

Many of Mpala's species fluctuate across the years. Elephant migrate in and out. Jackals have undergone several boom and bust cycles since the early 1990s. Buffalos tend to crash in droughts. Kudu may have had a dip a decade ago. I think there are booms of rodents, and later puff adders, after rains break droughts, but cannot be sure. Those most mobile of animals, birds, dramatically come and go with droughts (south from Samburu) and rainy periods (north from Nanyuki).

A greater kudu.
Photo by Bill Wechter.

We can always be sure of more changes in the future with many that we cannot anticipate today. I personally dream of unfenced Black rhinos once again ranging through Mpala. ■

Digging Out Dirty Dams

The newly repaired High Dam (above) and Ngaramata Dam (below) await the rains to refill. Photos by Alick Roberts.

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reliable internal source of water: our dams.

In the early 1980s, only four dams existed on Mpala: two big dams in the north and two smaller, stone dams in the south. The trampling and land degradation caused by animals going to water can often become a problem when there are such few sources of water across the land. Therefore, former ranch managers John and Ken Wreford-Smith built an additional twelve soil dams with the help of the British Army over the last two decades. Today, sixteen dams scattered across Mpala help to keep the cattle healthy through drought.

Over the years, the dams have silted up, and in early 2010 two dams – Ngaramata Dam in the north and High Dam in the south – broke after several heavy rainfalls. With the help of contractor Piers Daykin and Mpala's Workshop Manager Alick Roberts, Mike is currently making sure that all the dams are cleaned of silt and have their spillways repaired. So far the team has cleaned out one of the original stone dams and repaired and de-silted the two dams that broke earlier this year.

Thanks to donations from the trustees, Mpala will soon have its own equipment to ensure the upkeep of our dams and buffer the effects of droughts in the future. ▪

Mpala Publications 2010

This list is comprised of the publications related to Mpala Research Centre released within the second half of the year (Please see the July 2010 edition of Mpala Memos for the first half of the year):

Augustine, D.J. 2010. Response of native ungulates to drought in semi-arid Kenyan rangeland. African Journal of Ecology 48: 1009–1020.

Fischhoff, I.R., Sundaresan, S.R., Larkin, H.M., Sellier, M., Cordingley, J.E., Rubenstein, D.I. 2010. A rare fight in female plains zebra. Journal of Ethology 28: 201-205.

Fox-Dobbs, K., Doak, D.F., Brody, A.K., Palmer, T.M. 2010. Termites create spatial structure and govern ecosystem function by affecting N2 fixation in an East African savanna. Ecology 91: 1296-1307.

Goheen, J.R., Palmer, T.M. 2010. Defensive plant-ants stabilize megaherbivore-driven landscape change in an African savanna. Current Biology 19: 1768-1772.

Guajardo, J.C.R., Schnabel, A., Ennos, R., Preuss, S., Otero-Arnaiz, A., Stone, G. 2010. Landscape genetics of the key African acacia species Senegalia mellifera (Vahl)- the importance of the Kenyan Rift Valley. Molecular Ecology 19: 5126-5139.

King, E.G., Caylor, K.K. 2010. Herbivores and mutualistic ants interact to modify tree photosynthesis. New Phytologist 187: 18-22.

Kinyua, D.M., McGeoch, L.E., Georgiadis, N., Young, T.P. 2010. Short-Term and Long-Term Effects of Soil Ripping, Seeding, and Fertilization on the Restoration of a Tropical Rangeland. Restoration Ecology 18S1:226-233.

Kuria, S.K., Villet, M.H., Palmer, T.M., Stanton, M.L. 2010. A comparison of two sampling methods for surveying mammalian herbivore impacts on beetle communities in the canopy of Acacia drepanolobium in Kenya. African Entomology 18: 87-98.

Ogada, D.L., Keesing, F. 2010. Decline of raptors over a three-year period in Laikipia, Central Kenya. Journal of Raptor Research 44: 129-135.

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A playful leopard enjoying a roll in elephant dung.
Photo by Margaret Kinnaird.

Mpala Publications 2010

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Palmer, T.M., Doak, D.F., Stanton, M.L., Young, T.P., Bronstein, J.L., Goheen, J.R., Pringle, R.M. 2010. The joy of sets: synergy of multiple partners increases fitness in an ant-plant mutualism. Proceedings of the National Academy of Sciences 107: 17234-17239.

Pringle, R.M., Doak, D.F., Brody, A.K., Jocque´, R., Palmer, T.M. 2010. Spatial pattern enhances ecosystem functioning in an African savanna. PLoS Biology 8: 1-12.

Rubenstein, D.I. 2010. Ecology, social behavior, and conservation in zebras. In R. Macedo (Ed.), Advances in the Study Behavior: Behavioral Ecology of Tropical Animals, Vol. 42, PP. 231258.

Sensenig, R., Demment, M., Laca, E. 2010. Allometric scaling predicts preferences for burned patches in a guild of East African grazers. Ecology 91: 2898-2907.

Treydte, A.C., Riginos, C., Jeltsch, F. 2010. Enhanced use of beneath-canopy vegetation by grazing ungulates in African savannahs. Journal of Arid Environments 74: 1597-1603.

Veblen, K.E., Young, T.P. 2010. Contrasting effects of cattle and wildlife on the vegetation development of a savanna landscape mosaic. Journal of Ecology 98: 993-1001.

Wambuguh, O. 2010. Conservation of biological diversity in developing countries: the issues, challenges and possible solutions. A case study in the Laikipia District of Kenya. Lambert Academic Publishing.

Woodroffe, R. 2010. Ranging behaviour of African wild dog packs in a human-dominated landscape. Journal of Zoology, doi: 10.1111/j.1469-7998.2010.00747.x.

Yusuf, A.A., Pirk, C.W.W., Crewe, R.M., Njagi, P.G.N., Gordon, I., Torto, B. 2010. Nestmate Recognition and the Role of Cuticular Hydrocarbons in the African Termite Raiding Ant Pachycondyla analis. Journal of Chemical Ecology 36: 441-448.