

Thelma

Serengeti National Park

This prologue is to set the scene for the story about Thelma, a giraffe who is in great need of a Vet.

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The Serengeti National Park is the largest of several similar parks managed by TANAPA (Tanzania National Parks Authority) an agency of the Tanzanian Government. TANAPA are tasked with implementing the General Management Plan which runs eco-tourism and park operations.

At around 1.5 million hectares the Serengeti is home to over 120 species of mammals and around 750 species of birds, making it one of the most diverse biosystems on earth.

There are over 30 species of large herbivores with over 1.5 million blue wildebeest, around 200,000 Plains zebra and around 7,000 African Bush elephants, 70,000 Cape buffalo. There are roughly 13,000 Masai giraffes and hundreds of bloats (pods) of hippos estimated to be around 3,500 in total.

There are many antelope variations which include the massive eland, topi (high speed antelope who top 50 mph), hartebeest, waterbuck, impala and tiny Kirk's dik-dik and thousands of Thomson's and Grant's gazelle.

These herbivores are part of the complex food chain which feed the many predators which share the park with them.

Large carnivores include around 4,000 lions operating in hundreds of distinct prides. The Serengeti is home to the largest number of spotted hyenas in Africa, believed to be around 8,700 operating in clans or cackles of around 40 to 80 members. There are about 1,000 leopards and about the same number of cheetah.

Other smaller mammals include olive baboons, monkeys, honey badgers, mongooses, crested porcupines, aardvarks, bushbabies and dozens of rodent and bat species.

In a recent Serengeti initiative supported by Glasgow University, the African wild dog is being re-established in a scheme similar to the reintroduction of the wolf in Yellowstone National Park in the USA.

Raptors include martial eagles, tawny eagles, secretarybirds, bateleurs and six separate species of vultures. Endemic birds found only in Tanzania include Fischer's lovebird, the greybreasted spurfowl and the rufous-tailed weaver. The Maasai Ostrich (the world's largest bird at 2.75 metres and 155 kilos) is nomadic and, although the population is stable, it is a rare

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sight. Easier to see are the critically endangered Kori Bustard (the world's heaviest flying bird at 19 kilos and 1.5 metres standing height), especially when they gather during the locust season.

There are over a hundred species of water and wetland birds found on rivers and seasonal pools including flamingos, marabou storks, sacred ibises, goliath herons (some over 1.5 metres tall), and several species of kingfishers. Song birds and insectivores abound with over 350 species including the vividly coloured lilac-breasted roller, superb starlings, hornbills, weavers and shrikes.

In operational terms, the Serengeti is roughly divided into four geographical regions. In the South, East and West regions, it often abuts other parks and protected areas under the control of TANAPA or neighbouring countries.

In the North, the Serengeti has a contiguous horizontal border with the Maasai Mara National Reserve operated by the Kenyan Wildlife Service. This border exists only as a line on a map and stretches 160 kilometre (100 miles). There is no fence or barrier to restrict the movement of animals between the two parks which are part of the same greater ecosystem.

Tourism is a major money earner for the Tanzania government contributing around \$4.4 billion USD annually, a vitally important contribution equivalent to around 17.5% of Tanzania's GDP.

This money comes from safari tourists visiting the Serengeti and other TANAPA parks. Visiting these parks is expensive with separate day and overnight charges plus the high charges for safari tour operators and accommodation and food providers.

Generally, the service standards are high and most of the men and women involved in safari tourism are well versed in English and other European languages.

In the major centres of population in Tanzania there is an adequate and modern mobile phone and Wi-Fi coverage. However, those who operate inside the Serengeti Park rely heavily on satellite communications for voice and internet traffic, giving rise to an expensive but essential overhead.

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Tom and Hannah

Tom McLean eased his slim 6 foot 3 inch frame out of the cramped interior of the thirteen-seater bush plane and dropped onto the Seronera Airstrip and at once began a routine of twisting and bending to touch his toes, relieved to be able to stretch himself.

The plane was crowded, mainly well-heeled Safari tourists festooned with cameras and binoculars. He had been lucky to get a standby seat after waiting at the gate, taking the place of a passenger who had booked but did not turn up. As the last person to board, he did not get a window seat which would have given him spectacular views of the Serengeti National Park. However, with his drones, he planned to create his own Safari videos.

During his eleven hour flight from Heathrow Tom had dozed rather than slept and was feeling a bit woozy, other worldish. Standing aside while the safari passengers fussed over their luggage before moving to the vehicles waiting in the car park beside the airport terminal building, Tom took a long drink from his water bottle, knowing it was important to rehydrate.

The young Scot had been travelling for almost a full day since leaving Glasgow, using a travel voucher his parents had given him as a reward for gaining his PhD a few weeks earlier. His iPhone showed it was 16:43, Tanzanian time, three hours ahead of GMT. During his four hour stopover in Kilimanjaro Airport his phone had adjusted itself when he connected to the free airport WiFi.

While waiting for the Seronera flight Tom checked for a *WhatsApp* from Hannah then remembered there was no cell phone coverage in her area of the vast Park where TANAPA ranger groups used satellite phones to communicate by voice and email, albeit the use of this service for 'private' messaging was frowned on because of cost.

With the single engine turned off, the first thing which hit Tom was the cacophony of background noise from insects and birds and, in the far distance, the insistent bellow from an elephant calling to her wayward calf.

When he was the only one still waiting near the Cessna, he was approached by a stocky, strongly built fit-looking man. Later, from Hannah, Tom was surprised to learn this man was nearly sixty years old. Ten years earlier he had become a TANAPA ranger, after three decades as a safari guide pandering to the demands of rich safari tourists.

His name tag informed.

Juma Mwita

Senior Ranger

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The man spoke in clear English with a slight American intonation, his hand outstretched.

'I guess you must be Tom Mclean. Welcome to the Serengeti National Park.'

'Yes, Tom McLean, guilty as charged.'

'Juma Mwita at your service. Hannah is waiting for us at the Ranger Station. She was planning to come with me but got caught up in an emergency. A young male baboon fell heavily from the roof of a moving safari vehicle. He's in a bit of a mess, a broken leg and suspected head and internal injuries. Dr Asha Mrema our station Vet is away at Arusha HQ attending a seminar where she is hoping to persuade the TANAPA hierarchy to allow us extra resources and medications for our operations here at Seronera. Hannah is covering for her absence. Be warned, Tom, Asha Mrema is a very go-ahead and progressive person. She gained her PhD at Glasgow University ten years ago and it was her who persuaded me to join her team.'

Mwita lifted Tom's larger camouflaged rucksack containing his drone gear while pointing to the car park:

'That's my vehicle.'

Tom saw a dusty, well-worn Toyota Landcruiser.

'Our Ranger Station is about two hours away. Your flight was late. It will be dark for the last part of our journey. At night our tracks are well used by our animals, both prey and predators. Night-time is always busy and can be quite dangerous. We never allow safari vehicles to move at night except by special arrangement and with us to protect them. This is a duty we charge extra for. Today you get the night experience free. Keep a camera handy but no flash allowed.'

Juma drove in silence, covering the ground quickly, concentrating, slowing to pass the occasional elephant or group of elephants using the track as their personal highway. Over the next few days Tom would learn Juma was reserved, wary of strangers but open and talkative with friends and colleagues who had earned his trust.

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When they arrived at the Seronera Ranger Station, Hannah was waiting, caught in the headlights. She rushed forwards and threw her arms around Tom's neck, pulling his head down onto her lips, causing her safety glasses to tumble to the ground. In the gloom, the air was filled with huge flying insects (up to 28 mm in size) and what seemed like millions of moths.

'Oh Tom, what a lovely surprise. I just got your message early this morning, forwarded from Asha Mrema in Arusha. And well done, very well done indeed, completing your PhD in just three years. But what else would we expect, eh? You always were a clever clogs,

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breezing through your Batchelor's ¹ to get a First and the Class Prize for top student in our year.'

'Hannah, you look amazing *and* you smell wonderful. How did it go with the baby baboon?'

'Sadly my little Bobby Dazzler died. We'll all miss him, he was a great wee character. Internal bleeding we think. As you know we have only basic facilities here. Back in Glasgow we would have been able to detect the issue and might have saved him, who knows.'

'Yes, field medicine must be hard work. I suppose you must lose a lot of patients like that.'

'True, we function at a pretty basic level here. Getting to an injured animal quickly is always the best approach but in this case wee Bobby was brought to us the next day which was probably already too late. It's one of the hardest parts of being a Vet here, loosing patients due to lack of facilities and medications. Often the best we can do is euthanise them to limit their suffering. Anyway, let's not dwell on it.'

A huge insect bounded off the side of his head.

'Right Tom, let's get inside before you get hit in the face by a dung beetle, hence the safety specs. Here, put these on. I got Mum to send out a pack of a dozen but the Rangers refuse to wear them. What Asha calls TMMS - *The Macho Men Syndrome*. But as July is the dry season and quite a bit cooler, the nighttime biting insects are not around. They can be a real menace, to fend them off we have to rely on DEET, such horrible smelly stuff.'

'I've brought 'Skin so Soft'. If it deters the Scottish Midge, it might even work here.'

'Aye, right! Anyway, I've fixed us up with a cabin with a real bed, luxury or what? But first come and meet the rest of the team. We're just about to eat and yes, we've a nice veggie curry I made for us earlier.'

The couple had been vegetarians from secondary school days when Hannah had persuaded Tom to 'convert'.

The camp sleeping accommodation, a mixture of tents and cabins, was inside a fenced enclosure to prevent nocturnal intruders. During the meal, Tom was told of the danger of snakes such as the Black Mamba, Puff Adder and Black-Necked Spitting Cobra, and warned to always check with a torch when moving around at night.

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BVMS (Bachelor of Veterinary Medicine & Surgery)

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Lying side by side under a mosquito net after their love-making, Tom experienced his first nocturnal soundscape, a mixture of elephant calls, zebra grunts and raucous shouts and screeches from baboons, monkeys and birds settling to roost.

After dusk the sound of the cicadas had already faded, replaced by crickets and their cousins the katydids providing a constant outpouring of clicks, hums and rasping sawing sounds.

Time passed.

Tom's mind drifted back to his PhD thesis. He had been flying drones since he was sixteen and was fully qualified including an Instructor's Licence. During his PhD thesis project, Tom had worked closely with his supervisor Professor Peter Kendal using his drones in real situations to develop a range of protocols and special equipment for use in the field. Initially, his work had been with sheep, assisting hill farmers. Later, it had been extended to cattle, horses, feral goats and even nocturnal badgers using his drones infra-red vision capabilities.

Tom sensed Hannah was restless.

'Hi Honeybun, still awake? What's on your mind?'

'No, it's nothing, just the usual jumbled thoughts.'

'Tell me about them. A problem shared and all that Jazz.'

Hannah reached over and turned on her dim night light.

'Look Tom, I was thinking about us, about the future and in particular about your 'TechVets' business idea. Look, I know you and Prof Kendal have secured a start-up grant from Scottish Enterprise but in this day and age £250 K won't last long, will it? And what about liability insurance if something went wrong? And if the big boys from down south decide to steal your ideas before you get them patented, you would not be able to fight them, would you? Would you not be better looking for a partnership in an existing Vet Practice, start as an Associate? Somewhere near Perth would be nice. Maybe we could find a plot and build an Eco Home? They are really quite cheap to build and they are more or less self-sufficient with solar panels and a small wind turbine. Maybe we could have a water turbine and a battery storage system. And a polytunnel. Maybe we could live off grid and use satellite phones, like the Rangers do here? I suppose I sound paranoid but this TechVets idea really worries me. Everything seems to be drifting out of control. It's as if Peter Kendal is taking over our lives. It all seems to be coming at me in a rush. Look Tom, I know you've tried to keep me in the loop over the last year but with me over here, I've felt, well, 'unnecessary', if that makes any sense.'

Tom turned on his side to face Hannah, leaned in, whispered in her ear:

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'Hannah, you know I love you. I've loved you since S2 at Knightswood. I'm sorry to remind you but I wasn't dead keen for your to come here to the Serengeti with all its risks and discomforts but I could see that you wanted it so much. Being a hands-on Vet, when you opted for the post-grad diploma in 'Conservation Management of African Ecosystems', I suppose coming here for a year was almost inevitable. But you must agree, please, I've always had the idea of using drones to make Vet methods more efficient and more effective.'

'I know Tom, I know. Look, I'm sorry I sounded off at you like that.'

'Hannah, please trust me, I know we can make this work for both of us. Being an Associate in a rural Vet practice sounds like it would be ideal for you. So why not rural Perth in an Eco-Home with solar and wind power and a small EV car like your father's or maybe a second-hand EV van. Living a rural life seems ideal to me, so long as we have reliable Internet. I expect we could charge a satellite dish and phone and Internet subscription to the *TechVets* account.'

'Really? I thought you would want to stay in Glasgow, to be near to Prof Kendal and the Lab Team.'

'No, a rural life sounds good to me. And here's another idea I've been hatching. I'm hoping to use my drones to showcase your work here. Maybe we can interest one of the broadcaster to buy a video piece called 'Hannah's Serengeti Story'.'

'Yeah, that sounds great but Tom, are you sure you can make *TechVets* work remotely like that? I thought you would need an office and workshop beside Prof Kendal at the West of Scotland Science Park. I don't want to find I'm stuck out in the wilds alone while you are haring back down to Glasgow for meetings with Peter Kendal every few days over some new crisis or other.'

'No Hannah, I'm sure with good Internet and regular online meetings, you and I can make both of our careers work well. And remember, Peter Kendal is a pretty savvy operator. *TechVets* is not his first start-up and he reckons we have a good chance of getting ahead of the pack. Before they awarded our grant, Scottish Enterprise put us through the mill on the financials. And Peter has already started to leverage the SE grant to attract a few other agencies who are thinking of helping us. You can see from *Landward*, *Countryfile* and *Spring Watch* that 'Efficient Eco-Farming' is high on the UK political agenda nowadays.'

'Yes, okay, Tom, I know that drones are more effective than a shepherd and two collies on a quad bike. And much, much safer. And look, I know you're right. I know I was dumping all my anxieties on you. And I do trust you. I mean, everyone knows you have a quick mind and that your dogged, dedicated and focussed. Really, you haven't changed a bit. I mean you were Dux at school after all and when you got a First in your BVMS and won that

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£2,000 prize for 'Innovation in Vet Medicine', I was so proud of you. Even before that I knew the deal was done. I mean, it just had to be drones. And it was so good of you to agree to allow me to use that money from our joint account to help kit me out for my year out here in the Serengeti. But Tom, before we leave it and move on, let me get it all out, just this one last time, please. Okay?

'Yes Honeybun, shoot!'

'Look Tom, what I'm trying to say is that at the beginning, when you got going with your PhD under Prof Kendal I felt as if I had 'lost' you to him. Even when we were together alone, you were obsessed with what the two of you were up too. Back then I wished you would give up your PhD and try for a job as an ordinary Vet. You became so engrossed in your drone experiments I really resented it. That's part of the reason I wanted to try for a place here in the Serengeti, to create a bit of space for both of us. I worried you had given up on me altogether. Look, I did not expect it to be so difficult to communicate. I had not realised we can only use satellite between to team here and not for personal stuff. Then this morning when I got the message out of the blue that you were at Kilimanjaro Airport and would be here within a few hours, I thought, well . . .'

'Yes?'

'Well, just what I've been saying. Sorry it all came out in such a jumbled rush.'

Tom eased himself up onto his knees and stared down, waiting, smiling, his eyebrows raised.

'Hannah, you know what I really want, don't you? What I've wanted more than anything? For years now. So, what's it to be?'

Hannah's face cracked into a wide grin and she replied with a chuckle in her voice:

'Yes, Tom, this time my answer will be **yes**. Now that we have your PhD behind us, we can focus on the future and make it work for both of us. So, if you ask nicely, I will say yes.'

Tom reached for his day sack and produced a small scuffed pale blue box containing an antique ring which had been his great-grandmother's. The design was a cluster of five blue sapphires surrounding a large central diamond. Valued at £18,500, it had been professionally cleaned and adjusted to Hannah's ring size.

'When we return to Glasgow together in mid-August, will you agree to marry me asap, please?'

Hannah sat up knees to knees, put on her headtorch and slipped on the ring.

'Oh Tom, it's beautiful, really, really beautiful. It must have cost you an absolute fortune.'

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'Not a penny. It was a gift from my mother to me for you. It belonged to Great-Gran Brownlee. As Mum pointed out, the sapphires exactly match the colour of your eyes. She said it was meant for you, predestined.'

'It's a perfect fit too, how clever you are. I feel like Royalty.'

'You are Royalty, my Princess Hannah of Garscube ².'

'Tom, you are such a lovely, lovely man. How about we try for Halloween, on my birthday? And let's keep it simple, cut our costs to a minimum and do it at my father's golf club. Let's ask everyone to dress up as their favourite animal, face paints as well. What do you think?'

'Sounds perfect to me.'

Hannah placed the ring back in its box, stowed it safely in her carry pouch and removed her headtorch, leaving the night light at dim:

'Roll onto your back Big Boy - my turn to be on top.'

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The main teaching and research laboratories for Glasgow Vet School are based the Garscube Estate, near Bearsden.

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On the second day after his arrival at the Seronera Ranger Station, Tom and Hannah set out as part of a small team to search for a giraffe which was reported as poorly, acting strangely, clearly distressed. They travelled with Juma and his colleague Jabari Msuya in the Landcruiser. The Rangers were present to oversee their activities and to lend support to the young Vets.

This female was believed to be around ten years old ³, a wise leader with a loose following of up to a dozen or so other females with their calves. She was well-known to the Serengeti Rangers because of her limp, dragging her rear left leg, cause unknown. This injury had healed naturally and had not affected her mobility or ability to breed. For much of the year she stayed close to the Seronera Station. Hannah had named her Thelma after her cat back in Knightswood who had similar markings to the giraffe.

In July, during the dry season, Thelma was known to drift slowly northwards browsing the green tops of acacia-like trees and other thorny shrubs, picking the freshest leaves and shoots.

Most recently Thelma had been spotted travelling alone near the Masai Mara border, moving erratically, sometimes walking, sometimes cantering, her body thin, her head down and clearly in poor condition. A few days before this latest sighting, Thelma had been seen head butting some of the younger giraffes in her 'tower' (family grouping). From these reports there were no obvious signs she had been attacked, no clear explanation for this strange and uncharacteristic behaviour.

It was agreed the situation could not be allowed to continue. Juma Mwita would lead an expedition to investigate.

On the previous day Tom had demonstrated his drones and in a question and answer session he explained how he used them. Juma had been impressed and immediately agreed to Tom's suggestion that he assist by using his drones to attempt to locate and assess Thelma remotely, if she was still alive.

In the wild, injured giraffes can be unpredictable and dangerous. Should the wayward giraffe become overly aggressive, Jabari carried a high-powered rifle which fired an

³ In the Serengeti, female giraffes can live for twenty-five years. Breeding males are often lone bulls that move between groups, competing for receptive females rather than staying attached to a permanent tower. Because of injuries sustained when fighting other bulls for a female, males often live shorter lives. All giraffes *have unique coat patterns*—their spots are different enough that researchers can identify individuals from photos, much like fingerprints. These markings do not change much as they age, which makes them useful for long-term monitoring in the wild.

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anaesthetic dart capable of downing the giraffe using a minimal dose from which she should quickly recover. The optimum target area is the upper neck near the head, closest to the brain. However, hitting this target on a fast moving giraffe with its lolloping stride pattern would not be an easy shot. Further, if the animal was brought down while moving at high speed, because of its momentum, the giraffe could suffer one or more broken legs or internal damage which might prove impossible to treat.

Based on what they had seen from Tom's video clips on his laptop, Juma and Jabari had quickly agreed Tom's suggested alternative approach using his drones was a better option than shooting at Thelma with a high powered rifle.

Tom had a range of drones each for a specific purpose. His S-Type search drone was a modified version of the DJI Mavic 3 Pro, with a footprint diameter of 400 mm (14") , a flying range up to 20 km (12 miles) and a weight of just under a kilo (about 2 lbs). Its battery endurance in light winds was around 40 minutes and it could be back in the air within minutes after recall using a supply of quick-change lightweight batteries. At cruising and hovering height of 200 metres, it was effectively silent to humans and most animals.

The S-Type was Tom's workhorse drone but he had other smaller and quieter versions where stealth was important. His S-Type' which was rigged for search and tracking, was most frequently used to locate missing sheep or animals who had escaped from an enclosure, most often pigs and piglets, soon discovering that as well as being excellent escape artists they were also proficient swimmers even taking to the open sea lochs on occasions.

By hovering above an animal out of hearing range, adjusting his camera and tuning his infra-red heat and other specialised sensors, Tom's drones could capture a video clip and a wealth of supporting medical data. In Scotland, in a farming situation, he had used his drones to capture images of ear tags, note injuries and collect data of body surface temperature and respiratory distress and heart rate irregularities. If required, he could carry out a detailed remote survey of every part of an animal checking for any signs of leg breaks or injury, triage information used to assess the medical condition of the target with pinpoint GPS accuracy, particularly useful if the location was remote, unusual or potentially dangerous for humans to access.

If thought necessary he could deploy a smaller, quieter back-up drone to attach fluorescent yellow lentil-sized tracking tags released in a stream of individual transmitters in batches of fifty to rain down onto the animal. Each 'lentil' was encased in a powerful adhesive jacket which attached to the target to allow active drone tracking.

These tiny transmitters had been developed cooperatively with Engineering colleagues at Glasgow University, specialists in electronics and communications. They were hybrids of similar transmitters developed for humans in laboratory controlled situations but

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modified to Tom's specification for use with animals in the field. Each lentil was uniquely coded. Those which did not attach lay dormant and after a short time became inert, removed from the tracking loop.

The preferred attachment area was the nape of the animal's neck where it would be most visible to the search drone and, from experience in the field, most likely to stay in place. To extend its battery life, the drone tracker emitted a 'responder signal' which the attached lentils responded to when activated by an overhead drone flying within 500 metres of the animal. This meant that by flying at a cruise height of 200 m above the search area, the transponder would activate without alerting the animal being tracked.

In most situations, Tom's drone surveillance and data gathering approach method often proved cheaper and more effective than deploying the manpower needed to find and track a missing animal on foot or using a quad bike.

Although his modified drones were highly sophisticated, over recent years they had also become increasingly affordable. Tom's father, Dr Murray McLean, who worked as a backroom boffin for Police Scotland, was also promoting Tom's drone approach for investigating dangerous situations and incidents and for use in tagging suspect vehicles and known criminals fleeing from a crime scene.

Like the DJI Mavic 3 Pro used as the basis for his S-Type workhorse, all of Tom's drones incorporated three cameras comprising wide angle, telephoto and micro view. With the help of his colleagues at Glasgow University, he had developed a modified hand held tri-controller capable of operating up to three drones as a squadron, usually with two drones on hover standby while he manipulated the active drone. Using three drones meant he could recall each drone in turn for a quick battery change and thereby maintain constant surveillance.

This tri-controller had an HD colour screen and acted as an interface to capture the stream of incoming data from each drone and stored it automatically on a USB flash drive plugged into the controller for onward transfer to his laptop for later more detailed analysis and editing.

Tom's S-type drone could be transformed by adding an underslung bracket to act as a launch platform for an array of three syringe darts, each powered by a high-pressure air capsule which was virtually silent. These syringe darts could be used to deliver either a sedative or, in cases when a diagnosis had been confirmed, a prescribed dosage of antibiotic or other alternative medication allowing the animal to be treated remotely according to a predetermined schedule, making the treatment safer for both the animal and humans. This approach had been used to treat animals which were in pain or distress which could make them dangerous to vets and handlers.

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Sighting

The Landcruiser was parked on a hillock near to the last reported location for Thelma overlooking a sparsely wooded area of smaller trees surrounded by a ring of taller trees.

Tom sent up an S-type drone and began a systematic grid search. Fairly quickly he located a group of eleven giraffes, comprising three mothers and assorted calves. Tom copied their images to Hannah's laptop and she ran check against her database.

'Bingo! This grouping is part of Thelma's tower. One of Thelma's yearling female calves is in the group but her youngest calf, a male, which is about four months old is missing. It would still have been suckling. Unless it is still with her, it is probably dead due to starvation.'

Tom responded: 'Do you think Thelma is nearby? Are they tracking her, at a distance.'

Juma said: 'Tom, show me the overhead view of this tower again, please.'

Tom placed his drone directly above the group and they studied the video image on his laptop.

Juma said: 'Look at the three mothers. Look at the direction they are staring in.'

Hannah added: 'Tom, as you might remember from our undergrad studies, it is well established that giraffes have excellent eyesight. They can also track other members of their group using urine trails and although we don't know a great deal about their hearing, they do have the right shaped ears to suggest they have good hearing too.'

'Okay, I get it, the three mothers are pointing us at Thelma. Right, I'll send up another drone to look for her along that pathway and keep the original drone in place to keep track of this tower.'

About five minutes later, they spotted Thelma.

She was in a dreadful condition, very thin, her long neck down, her front legs splayed, swishing her head from side to side in long slow strokes through the foliage of a large low lying bush.

After a few minutes she raised her head and turned to look back towards her tower standing off in the distance. Making a low bellow, snorting and hissing she ran towards them and they scattered, running from her. Almost immediately Thelma lost interest, slowed to a standstill then ambled back to the bush and resumed her previous odd behaviour, swishing her head through the low bush. The other giraffes re-grouped, resuming their vigil, watching their distressed leader from a safe distance.

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Juma said: 'I think she has a problem with her mouth, maybe a broken or diseased tooth. We need to sedate her and check what can be done.'

'Yes,' said Hannah, 'I agree. Can you possibly do that for us Tom?'

'Okay, I'll have a go at that but first I'll attach the tracking lentils in case she decides to start running away from us. If she runs into those denser trees in the distance we might have a job finding her again.'

Tom swooped to about fifty metres directly above Thelma and released a batch fluorescent tracking lentils which attached themselves to her back. The giraffe seemed unaware and paid no heed to them. Because of the proximity of the tracker drone the lentils responded and a GPS location was captured by Tom's laptop.

He then raised the tracker drone back to 200 metres and locked it on GPS standby to continue to observe the distressed animal and her tower standing off at a distance.

He prepared a third drone attaching a launch platform loaded with three syringe darts, each with a measured dose of sedative as indicated by Hannah's weight profile for Thelma held in the database.

Tom used low and slow approach, skimming the tops of the vegetation on a line of approach which brought him directly behind the swaying animal.

With his drone hovering in a fixed position under GPS control at a diagonal distance of around twenty metres from Thelma's head, he was readying himself to fire his first syringe dart by studying the rhythm of the swishing motion and adjusting the direction and tilt of the drone, picking a spot when her head would be stopped at end of its swing arc.

His first dart missed and flew high, disappearing into the bush. He would search for it later to be sure it was not a hazard to other animals.

Tom rolled his shoulders and relaxed then waited, made a micro-adjustment to the drone and when he had re-tuned to the rhythm of her swishing movement, he fired his second syringe dart. Number two struck a glancing blow but did not attach. Thelma did not react and continued to swish her head through the bush as before.

His third syringe dart landed as intended. Thelma, leaned forwards, wobbled then collapsed slowly onto the bush and lay on her side.

Tom repositioned the drone and zoomed in to examine the sleeping animal, activating his array of sensors and checking her pulse rate had slowed and that her pupils had dilated.

'Action stations,' said Hannah. 'With that dose we have about thirty minutes before she starts to come round.'

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Tom replied, 'Hannah, I'll stay here and keep watching with the drones and capture everything on video, okay?'

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Thorn

The Landcruiser arrived at Thelma's location a few minutes later.

With his hand-held syringe at the ready, Jabari Msuya knelt beside Thelma's head, pressing it gently downwards, ready to inject a further dose of sedative if required. Their protocol was always to use the minimum dosage in order to help sedated animals to recover more quickly. Like the Hannah and Juma, the younger Ranger was wearing surgical gloves and a face mask.

Juma held open Thelma's mouth and Hannah eased her long tongue to one side.

The culprit was long vicious acacia thorn firmly and deeply lodged at the front of her lower right gum.

Hannah used her phone camera to take a few snaps then made a short video as Juma eased the thorn out and held it up while Hannah checked it, pleased that it looked entire, with no broken bits left in the wound site. Juma placed the thorn in a plastic bag for reference ⁴.

Using her phone torch and cotton buds, Hannah searched the wound site for any potential broken bits and found none.

Using a squeeze bottle with a long nozzle, she rinsed the wound with a sterile saline solution followed by a second rinse with diluted aqueous chlorhexidine, completing her treatment with an injection of ampicillin.

Using a special magnetic comb Tom had given her, Hannah removed the fluorescent tracker lentils from her back and shoulders and bagged them for re-use.

The trio retreated to the Landcruiser and they drove off a short way and waited, watching Thelma through binoculars.

Observing what had taken place from his location on the hillock, Tom sent a replacement tracker drone to take over from the syringe dart drone which he then landed beside the Landcruiser as its battery was almost spent.

After a short wait, Thelma recovered slowly, struggling to her feet to stand upright, swaying gently. She turned her head and then eased herself around to stare in the direction of her tower. Her group started to move towards her and over the next fifteen minutes or so inched their way closer.

⁴ The thorn was later identified as an umbrella thorn acacia (*Vachellia tortilis*).

Thelma

Thelma remained stationary while rocking her long neck slowly up and down as if saying *"Yes, it's alright to come to me now"*.

Her yearling daughter was the first to approach her, nuzzling and rubbing against her. This broke the ice and soon Thelma was surrounded by the remnant of her original tower.

After a few minutes of socialising, Thelma moved off, leading them in a tight-knit group towards the denser wooded area where they disappeared. Tom used his tracker drone to follow them filming until they disappeared.

Juma and Hannah agreed they had done their best for Thelma knowing that she must make her own way and, hopefully, begin to heal and feed again to recover to full health.

The Landcruiser returned to the spot where they had treated Thelma and after a careful search, recovered and bagged the two failed syringe darts and checked for any remaining tracker lentils and used cotton buds.

Back in the Landcruiser with Tom on board and Jabari Msuya at the wheel, Juma made a satellite call to the Seronera Ranger Station to explain what had occurred and advise that they should arrive back before dusk.

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From the Ranger Station, Juma and Hannah compiled a synoptic report and uploaded it to the TANAPA database at Arusha HQ, sending a link to Dr Asha Mrema. A few minutes later, she called and asked for a detailed explanation, quizzing Juma, Hannah and Tom until she was satisfied with their approach and the outcome. During this long conversation, Tom explained his idea of making a promotional video and Asha was immediately supportive and enthusiastic.

Starting early the next day Tom compiled his various drone video clips from their search and rescue operation inserting the photographs and video clips of the dental treatment from Hannah's phone. When this was done he invited Hannah and Juma to add their voice-over comments and explanations, coaching and re-scripting their words until all three were happy with them.

This first rough compilation version would be later refined with additional drone and interview footage of the work of the Seronera Rangers and interviews with the other team members going about their daily duties to eventually become a professionally edited version of 'Hannah's Serengeti Story' which Prof Kendal sent to his media contacts and used to assist with fund raising for *TechVets*.

Thelma

Drone Pilots

On her return to the Seronera Ranger Station, Dr Mrema watched the video and expressed her satisfaction with the work which Hannah had done with Thelma and with the methodology they had used with the drones to track and treat the distressed giraffe.

After they had viewed the then current version of Tom's video compilation, he suggested a plan in which he would coach a drone pilot and donate a small, training drone to the Station.

Asha suggested Jabari Msuya, knowing he was a techie person and keen to progress. In his role as their principal Ranger Station marksman, he had proven hand eye coordination skills. Asha also nominated Rehema Mnyika, a twenty-three year old Vet Nurse who had been with the Saragosa team for two years and was also a techie wizard, good at darts and table tennis.

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Their training began early the following morning. Tom used a more basic version of the smaller and lighter DJI Mini 4 Pro which like its larger cousin the DJI Mavic 3 Pro also incorporated the 'return to home' and 'three-dimensional obstacle avoidance' features. The small drone was robust and had already withstood many crashes without harm. It was his starter drone with a simple camera setup which he previously used to introduce beginners to drone flying.

Tom removed the stress element which would arise if they were scrutinised by others, he took Rehema and Jabari well out of sight of the Station, insisting they sat on comfortable chairs beside him while he demonstrated the basics before giving them their first opportunity to make a drone flight.

These first sessions went well and by noon both budding drone pilots were making short circular flights, taking off and landing from an old dart board which they used as a landing pad. After lunch, the sessions continued until his supply of replacement batteries for the training drone was exhausted.

On day two he upgraded them to one of his S type tracker drones (a modified DJI Mavic 3 Pro), the sort he had used to locate Thelma. In the afternoon he set them a challenge to fly the drones in a matched pair in the direction of the Station, their first flights with a drone out of visual contact which meant they must rely on the information being sent back to the screens on their hand held controllers. On their first few attempts, they got 'lost' and used the 'return home' feature to retrieve their drones. However, after a few more tries they were reaching the Station and returning using the drone

Thelma

camera and hand-held controllers with increasing confidence, learning to soar higher to get a better overview and orientation of their starting and target points. It was clear they both had the potential to become proficient and professional drone pilots.

By day three, Rehema and Jabari were both flying S type drones and recording their own short video clips for downloading to Tom's laptop.

By the middle of the second week Tom judged that Jabari and Rehema were competent recreational drone flyers and would meet the regulatory standards required in the UK.

On the final afternoon before Tom and Hannah were due to fly home to Scotland, Tom set up a demo for the Saragosa Rangers Station during which Rehema and Jabari flew tracker drones sending them zooming around the Ranger Station, landing and taking off in unison and doing simple loops and swoops.

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On their return to Glasgow, Hannah learned in an email from Dr Mrema that she had used a copy of Tom's 'Thelma video' together with a copy of the 'final day demo' video by Jabari and Rehema to persuade her supervisor at TANAPA HQ in Arusha to enrol Rehema Mnyika and Jabari Msuya on the 4 week drone flying qualification course at CATC⁵.

In response to this news, Prof Kendal persuaded the Veterinary School Finance Committee to allocate a grant of £20,000 to fund a package of professionally modified TechVets drones to be sent to the Saragosa Ranger Station under the existing the GU-Serengeti Funding Scheme.

Tom and Hannah are progressing their plans for their wedding. Hannah has secured a two-year contract with a Vet practice twenty miles north of Perth and they are currently looking for a site to build their dream eco-home.

Sightings of Thelma and her tower confirm she has made a full recovery and has re-assembled most of the original members of her group.

⁵ The Tanzanian Civil Aviation Training Centre is based at the Julius Nyerere International Airport, Terminal I at Dar es Salaam.