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SPECIAL ISSUE: DOGS AND CONSERVATION: CURRENT AND EMERGING CONSIDERATIONS

Examination of the K-9 unit at Akagera National Park

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Abstract. Tracking and sniffer dogs have been employed in a variety of law enforcement roles world-wide and are increasingly utilized to combat wildlife crimes (i.e. poaching and trafficking). I examined the K-9 counter--poaching unit based at Akagera National Park in Rwanda. I discuss motivations and reasoning for the unit's creation, and examine the challenges faced and methods used to overcome these. I also highlight successes and best practices in place at the Park. The major challenge encountered is health issues related to the parasitic protozoan *Trypanosoma* spp. Minor budgetary and facility challenges exist. Developing in-house solutions such as setting up a small clinic and basic veterinary training for handlers have reduced health risks and costs. Crossbreeding the original tracking dogs from Europe with local dogs from the communities around the park has been a success. Puppies bred and trained on-site offer affordable alternatives to purchasing additional dogs from abroad. The cross-bred dogs may also be better suited for working in the Akagera environment but further scientific study is needed to understand this. Additional successes include training dogs to track both on- and off-lead, allowing for a unit with multiple skill sets and more efficient, faster tracking.

Key words: conservation dogs, law enforcement, human-tracking, Rwanda, counter-poaching

Introduction

Protected areas often contain the highest levels of biodiversity and suffer most acutely from increases in poaching pressure as species most sought after by poachers are commonly confined to these areas (Dudley et al. 2013). As wildlife crime continues to expand globally, poaching activities for both trophy products (e.g. rhino horn, ivory) and bushmeat threaten many species with disruption of population dynamics, population decline, and extinction (Archie & Chiyo 2011, Becker et al. 2013, Dudley et al. 2013, Ferreira et al. 2015, Lindsey et al. 2015). Rapidly growing human populations along protected areas, limited access to alternative food sources, constrained economic resources, and increasing demand for animal products locally and internationally necessitate diverse strategies for addressing these drivers (Dudley et al. 2013, Knapp et al. 2017, Lunstrum & Giva 2020). The upscaling of poaching pressure and tactics has led to a parallel improvement in technology, intelligence, and force by conservation management, and an expansion of initiatives to target underlying drivers and community engagement (Hilborn et al. 2006, Dudley et al. 2013, Steinmetz et al. 2014, Steiner 2020). Working dogs are an emerging tool for managers and are increasingly employed for tracking and detection in conservation roles (Karanja 2012, Gompper 2014). Tracking dogs support rangers in the field by aiding them in locating and pursuing poachers following detection, while sniffer dogs are utilized in detecting bushmeat, horn, and ivory in vehicles leaving protected areas, markets, and points of entry and exit of a country (e.g. seaports: Karanja 2012, Beebe et al. 2016). As working dog usage expands into conservation applications across

Africa, managers need to be prepared to understand their application and the challenges associated with creating and maintaining canine programs. Canine units require preparedness, resources, and diligence to be effective. Health concerns and welfare are a top priority that need to be addressed, and remoteness, working conditions, and the breeds used all contribute to the challenges-faced and the types of solutions available (Jennings 1991, Toffoli & Rolfe 2006, Rooney et al. 2009). In remote settings, the possible absence of conventional veterinary care means canine programs must be able to compensate with training, good facilities, and logistical planning (Vogelsang 2007). Canine units are also expensive and can pose budgetary challenges to small conservation and management entities. A balance must be reached between the size of the unit, the need on the ground, and financial considerations. Operational capacity is also key and canine units can only be effective when there is capacity to deploy them quickly and efficiently. Practice, planning, and communication are critical components that must be in place for units to be successful in conservation roles.

Akagera National Park, Rwanda (Akagera hereafter, 1.64469° S, 30.70864° E) has been subject to continual heavy poaching and human encroachment until recently. Founded in 1934, Akagera represents the last remaining savanna habitat in the country and Central Africa's largest protected wetland (D. Macpherson & D. Bantlin, unpublished data). Abundant grass and water support over 13,000 large mammals (D. Macpherson & D. Bantlin, unpublished data). The park was reduced by nearly two-thirds to its current size of 1,120 km^2, following refugee resettlement in the 1990s. The influx of people into the park area led to massive population declines in all species through illegal bushmeat hunting, retaliatory killing, and poaching for trophy items, including extirpation of African lions (*Panthera leo* Linnaeus, 1758) and eastern black rhinos (*Diceros bicornis michaeli* Zukowsky, 1965). Illicit grazing by thousands of cattle contributed to habitat degradation and destruction. Improved security following a management agreement between the NGO African Parks and The Rwanda Development Board in 2010 has led to widespread recovery of the ecosystem and most species. The erection of a boundary fence in 2013 effectively stopped human encroachment and illicit grazing in the park, but poaching for bushmeat using spears and snares continued to be a challenge despite expanded law enforcement activities and capacity. Cape buffalo (*Syncerus caffer* Sparrman, 1779), impala (*Aepyceros melampus* Lichtenstein, 1812) and warthog (*Phacochoerus africanus* Cuvier, 1826) are the most commonly poached mammals.

Managers discussed bringing tracking dogs to Akagera multiple times after 2010 to combat this problem, but budgetary and capacity limitations prevented the creation of a unit until 2015 when eight Belgian malinois were acquired. This was completed in tandem with a general up-scaling of the park's security capacity and community engagement in preparation for the reintroduction of lions in 2015 and black rhinos in 2017 (D. Macpherson & D. Bantlin, unpublished data). The goal of managers was to create a unit that comprised local, professional handlers who could build strong relationships with their dogs and contribute to on-going counter-poaching activities in the park. The unit was envisioned to aid in apprehension of poachers through reactive patrols in response to poacher detection and participate in standard patrols, especially along the interface of the park with the local communities. Originally comprising eight dogs, the unit has been expanded to 16 individuals with abilities to track on-lead and off-lead in packs. Diverse modes of response were intended to allow the unit to be flexible and competent to respond to any situation that may arise.

I present an overview of the unit and their role, including challenges and successes. I focus on health, budgetary, and operational challenges that are faced in Akagera and provide summaries of each. Where possible I present actions that have contributed to addressing some of these challenges and give brief insight into areas that still need improvement in the hope that this information may be useful to established programs elsewhere in rural Africa or to managers aiming to start their own programs.

Material and Methods

Data were collected using two methods to examine Akagera's K-9 unit: interviews with key personnel and examination of health and budget records. Interviews allowed for insight into various aspects of the unit that are not explicitly captured in records. Interviews also provided an opportunity to understand how the unit operates, the challenges that are faced, and where successes

have been achieved. Alternatively, records provided quantifiable data that provide a snapshot of development and history of the unit.

Interviews with Akagera's park manager and K-9 unit team leader were structured as informal conversations where the interviewee was verbally presented questions to respond to. Questions broadly examined the background of the unit, dog health, budget, and operations. Challenges and successes were inquired about for each general category. Some questions were very specific (e.g. "what is the one-year budget for the K-9 unit?"), while others were less-focused and open-ended (e.g. "what are the biggest health challenges faced?"). Follow-up questions were asked for clarification and respondents were encouraged to share opinions and perspectives on the questions asked. Any additional information was welcomed. The data were summarized and key points are presented.

Available health and budget records for 2015-2020 were examined. These data included training logs and veterinary records of dog health and illness from January 2016 through May 2020. Health records focus strongly on trypanosomiasis cases, the treatment administered, and prevention. The costs of treatment per case are included in the records, as well as how and where cases were handled. The park's master budget was also used to explore the total cost of the unit, both in creation and maintenance. The three-year start-up budget (2015-2017) was examined to understand the initial costs and expenses for unit creation. Finalized budgets for 2018-2019, as well as projected budgets for 2020-2024, were also inspected to illustrate how costs have changed overtime. Simple summaries of these data are presented.

Recommendations are given to reflect the best practices at Akagera. Some recommendations reflect personal suggestions shared by the two respondents in their interviews, while others were generated through record examination and open discussion between the author and the two respondents.

Health

General health of the dogs is the greatest challenge and concern for the K-9 unit at Akagera. Health issues related to the parasitic protozoan *Trypanosoma* spp., especially, pose the most regular problems. The parasite causes the disease trypanosomiasis, and dogs are at risk both in the field and when housed in the kennels due to the prevalence of the tsetse fly vector in the park. Akagera is home to *Glossina morsitans* and *Glossina fusca*, both known to be vectors of trypanosomiasis (Murray et al. 1981, Moloo et al. 1988, Leak et al. 1991). Tsetse fly traps are used extensively around the kennel areas to reduce the number of flies and risk of transmission. "ZeroFly" tsetse fly traps (manufactured by Vestergaard SA, Place Saint Francois 1, Switzerland) come impregnated with insecticides, ready to deploy, and are effective in reducing the number of tsetse flies (Nagagi et al. 2017). Traps used in Akagera are impregnated with the insecticide Deltamethrin and have a persistency of approximately nine months.

Heat stroke and dehydration are lesser concerns during both training and operations. Dogs working off-lead are more prone to both when operating independent of handlers. Interactions with wildlife are a minor concern, with only one dog being attacked by a baboon in the past five years while on an operation. Kennel stress caused by dogs not getting out of the kennels enough and intra-unit accidents (e.g. dog fights) can occur, but are easily managed by competent and caring handlers.

Health challenges are minimized and overcome through preparedness, vigilance, and training. All handlers have first aid and basic veterinary training for disease identification, treatment, and care. All handlers received comprehensive training on dog behaviour, especially in the kennels, as part of their initial training following recruitment to allow them to detect abnormal behaviour quickly. This training also included first aid and evacuation protocols for injured and sick dogs, and training to understand and recognize signs of common diseases and injuries that dogs might suffer working in this environment. Handlers are all trained to administer medication, take blood samples for parasite surveillance, and administer fluids to a dog as needed, but this is typically done by the unit supervisor or team leader. Refresher training led by the unit supervisor, team leader, and external trainers is conducted yearly as part of the annual training. A basic veterinary clinic has been set up at the park headquarters and the K-9 unit team leader has had additional advanced training in disease identification, testing, and treatment. The in-house clinic is a small space that allows for examinations and treatment in a

clean environment, away from the kennels. Drugs are stored here, as well as laboratory equipment. A microscope is available for diagnostic use. An examination table and hooks to hang fluid bags was constructed. The clinic space also allows for a central location to keep calendars, schedules, and records. This has improved care for the dogs and data retention regarding health history and procedures. There is enough room in the clinic to house up to two dogs should they require prolonged care and observation away from the main kennel.

Trypanosomiasis is screened for daily because of its prevalence. The dogs' temperatures are taken each morning and any high readings above 39.5 °C are reported immediately. The dog's temperature is taken again in the evening if the initial reading is high or if they are showing signs of weakness or other symptoms. Dogs with high temperatures remain in the kennels under close observation of symptoms, behaviour, and activity. Other symptoms that are closely monitored for are loss of appetite, weakness, and lack of energy in acute cases, and excessive panting and restlessness in chronic forms (Nwoha 2013). Symptoms like swelling of the eyelids and lips, paleness of the mucus membrane, slow capillary refill, and opacity of the corneas are also checked, but require the unit supervisor or team leader who have more experience with these examinations (Nwoha & Anene 2011, Nwoha 2013). Seizures are watched for and heart rate is checked routinely in dogs presenting severe signs.

Prophylaxis has become part of the prevention protocol for some dogs, starting in 2017. Isometamidium under the brand name Intromidium

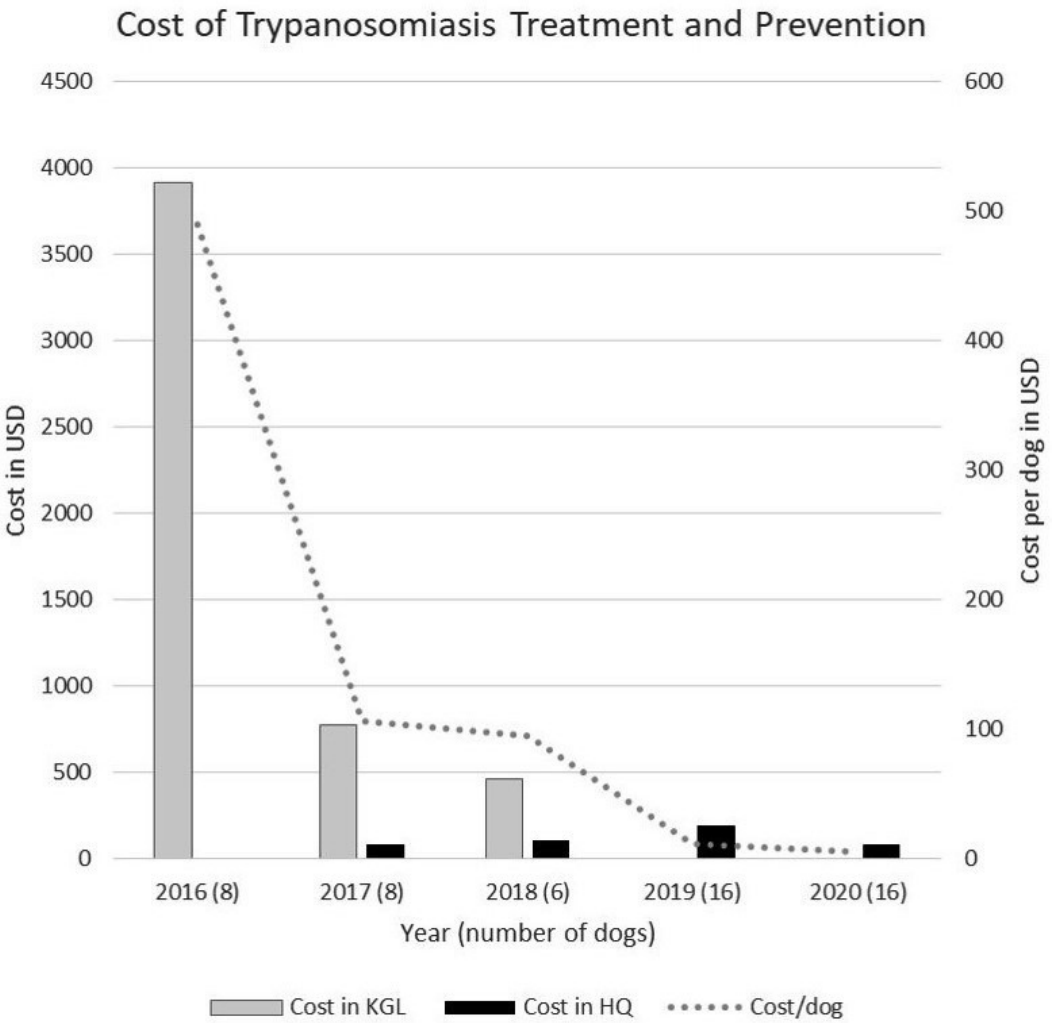

Fig. 1. The cost of trypanosomiasis treatment and prevention in USD for cases referred to Kigali (KGL) and treated at the park's clinic at headquarters (HQ). These costs represent the cost of administering prophylaxis or treatment to the dogs, only, not additional costs that may arise from logistics of transporting dogs to Kigali. The secondary axis shows the cost per dog per year in USD. The second number on the x-axis is the number of dogs in the unit each year. 2020 data is through May 2020.

(manufactured by Interchemie, Venray, The Netherlands) is administered deep IM at 0.5 mg/kg as prophylaxis. The original dogs brought from Europe receive prophylaxis every three months, and additionally receive Intromidium in the same dose as treatment when they have a confirmed case of trypanosomiasis. The two dogs recruited from the local communities are not given prophylaxis, but are treated when they present signs of infection. The cross-bred puppies received prophylaxis twice during their first year since birth, but after that are only administered treatment when presenting symptoms. The use of prophylaxis appears to have contributed to a reduced number of cases of trypanosomiasis, and has also reduced veterinary costs related to treatment of cases (Table 1, Fig. 1). Blood samples can now be taken and examined to confirm the presence of trypanosomes at the park's clinic. Blood is sampled from the capillaries in the ear following a recorded high temperature and the onset of additional symptoms, and a stained smear is used to diagnose trypanosomiasis (Uche 2010, Nwoha 2013). The stained slide is simple to produce and effective in detecting the presence of the parasite in the absence of more advanced tests requiring additional equipment like centrifuges (Nwoha 2013). Tests and procedures done in-house are instant and reduce the two-day waiting period when going to an external veterinary clinic. Improved screening, a well-stocked clinic, and basic veterinary training for handlers and team leaders has resulted in zero dogs lost to trypanosomiasis and zero cases being referred to Kigali since the park's clinic's establishment.

Lack of understanding and practice when the original dogs arrived in Akagera meant that most trypanosomiasis cases were treated reactively, following multiple symptoms and often once the case was already severe. Improved screening, including daily temperature checks, closer monitoring following high temperature records and observations for symptoms generally, and the capacity to perform blood smears quickly and often as needed has enhanced detection and response. While further improvements are needed in the scope of what can be done in the clinic, being able to get basic results quickly has improved the health of the unit greatly. However, severe cases are still referred to veterinarians in the city and a contingency plan is in place if dogs need to be transported there quickly. Dogs with severe or unknown illness, or major injury, are taken directly to an external veterinary clinic. The in-house clinic is limited in its ability to do follow-up or advanced tests. Follow-up blood work to monitor liver and kidney function, for instance, cannot be done in-house. Expanding the capabilities of the clinic and K-9 supervisor and team leaders would be

Table 1. Three-year start-up budget for the K-9 unit at Akagera National Park. Figures are in USD. The 2015 budget reflects nine months, not 12. The number alongside an item denotes the quantity.

Item	Three-year start-up budget		
	2015 (USD)	2016 (USD)	2017 (USD)
Dog handler salaries (16)	40,704	53,729	56,171
Driver salary (1)	4,435	5,913	5,913
Cook salaries (2)	1,884	2,261	2,261
Cleaning materials	348	348	348
Dog bowls and feeding appliances	400	400	400
Dog equipment	3,200	3,200	3,200
Dog food	10,957	14,609	14,609
Kennel repair & maintenance	0	2,500	2,500
Kennels and dog equipment	13,500	0	0
Veterinary costs and preventatives	8,000	8,000	8,000
Cook uniforms	87	87	87
Dog handler rations	7,652	8,682	9,016
Dog handler training materials	2,400	600	600
Dog handler uniforms	4,800	4,800	4,800
Driver uniform and equipment	350	350	350
Field equipment for handlers	2,720	2,720	2,720
Refresher training	0	3,000	3,000
Salary of trainers	0	18,000	18,000
Store container conversion	500	0	0
Vehicle fuel	2,504	2,755	3,005
Vehicle insurance	3,623	3,623	3,623
Vehicle repairs and maintenance	2,428	2,792	3,034
Total budget	110,492	138,369	141,637
Total three-year start-up budget	390,498		

beneficial going forward and is a goal, but the ability to do the basics given the current limitations has been positive for the unit. If a dog requires such follow-up monitoring, the animal is taken to Kigali for additional screening.

Rationale for not employing a full-time veterinarian include insufficient work to justify the cost, and the high level of training by K-9 unit team leader and handlers that allow them to do much of what the veterinarian would do day-to-day. Kigali is also only 2.5 hours away by car in case of emergency or the need for advanced procedures. While a veterinarian may also be able to assist with other duties in the park, snare removal is seldom needed and collaring operations are done in one effort each year. Translocations, disease monitoring, and emergency veterinary operations are carried out by a network of veterinarians that can travel to the park as needed. Many of these individuals have experience with working dogs and generously contribute to training and capacity building during their visits. However, having an on-site veterinarian would allow for more advanced disease screening and monitoring within the K-9 unit and may be considered in the future if the unit grows or other needs in the park increase.

One of the largest successes of the K-9 program has been cross-breeding local dogs with the highly-trained dogs originally donated to the park. While the donated dogs, Belgian malinois, possess desired characteristics for tracking and physical stature, they are highly susceptible to trypanosomiasis. Despite susceptibility, local dogs may possess some degree of tolerance to the trypanosomes, but this has not been scientifically demonstrated. Support for this comes from the fact that neither of the local dogs recruited to the unit have had a confirmed case of trypanosomiasis. Additionally, neither has

Table 2. The two-year budget for 2018 and 2019, and the current five-year budget plan through 2024 for the K-9 unit at Akagera National Park. 2018 was the first year that the K-9 budget was incorporated into the master budget for Akagera. Figures are in USD. The number alongside an item denotes the quantity.

Item	Two-year budget		Five-year expected budget				
	2018 (USD)	2019 (USD)	2020 (USD)	2021 (USD)	2022 (USD)	2023 (USD)	2024 (USD)
K9 supervisor salary (1)	19,072	19,643	20,232	20,839	21,464	22,108	22,771
Team leader salary (1)	4,032	4,152	4,277	4,405	4,537	4,673	4,814
Deputy team leader salary (1)	3,786	3,900	4,016	4,137	4,261	4,389	4,520
Dog handler's salary (7)	23,967	24,685	25,425	26,188	26,973	27,783	32,704
Kennel attendant salary (2)	2,772	2,855	2,941	3,029	3,120	3,214	3,310
Driver for K9 unit salary (1)	5,422	5,585	5,752	5,924	6,102	6,285	6,474
Cleaning materials	413	426	440	453	467	481	495
Dog equipment	3,099	3,198	3,300	3,399	2,334	2,404	2,476
Dog food	9,838	10,148	10,340	6,390	5,485	5,649	5,819
K9 Training	1,972	2,035	2,100	2,163	2,228	2,295	2,364
Kennel repair & maintenance	1,451	1,497	1,545	1,591	1,639	1,688	1,739
Veterinary costs and preventatives	3,099	3,198	3,300	3,399	2,334	2,404	2,476
Dog handler rations	3,379	3,379	3,379	3,379	3,379	3,379	3,379
Dog handler uniforms	2,440	1,220	2,440	1,220	2,440	1,220	2,440
Field equipment for handlers	2,040	0	2,040	0	2,040	0	2,040
First aid training	515	0	515	0	515	0	515
Ranger training	2,747	2,747	2,747	2,747	2,747	2,747	2,747
Vehicle fuel	7,573	7,815	8,064	8,306	8,555	8,812	9,076
Vehicle insurance	3,623	3,623	3,623	3,623	3,623	3,623	3,623
Vehicle repairs and maintenance	4,317	4,455	4,614	5,306	6,102	7,018	8,071
Total yearly budget	105,559	104,562	111,091	106,500	110,347	110,172	121,853
Total two-year budget	210,121		Total five-year budget				559,962

Table 3. The number of confirmed cases of trypanosomiasis by year, by cohort of dog. The second number presented is the number of the dogs in the unit each year. 2020 data is through May 2020.

Group	Confirmed cases of trypanosomiasis				
	2016	2017	2018	2019	2020
Original dogs	25 (8)	8 (6)	10 (4)	8 (4)	1 (1)
Village dogs	-	0 (2)	0 (2)	0 (2)	0 (2)
Mix-breed dogs	-	-	-	4 (10)	5 (13)

received prophylaxis in the past two years. This is likely because of a tolerance rather than resistance, but needs to be scientifically explored to validate the idea that cross-breeding European dogs with local dogs might produce puppies with some degree of tolerance. Two litters of puppies have been born in the park (born 20 July 2018 and 20 July 2019, respectively) and have started training. As older dogs are phased out, young animals bred and trained in-house are the most cost-effective alternative to purchasing adult dogs from abroad. While we have seen a reduction in the frequency of trypanosomiasis cases in the cross-bred puppies born in the park, it is impossible to be certain why this is (Table 3). Both litters received two doses of prophylaxis before turning one year old. Since then, the puppies only receive Intromidium as treatment if presenting signs of trypanosomiasis. Delays in starting the original dogs on prophylaxis following arrival in the park, differences in the prophylactic regimens between dog cohorts, and extensive tsetse control measures around the kennels are all confounding factors. While it is encouraging that the cross-bred dogs may be more suitable for working in this environment, a more deliberate, scientifically-robust study must be undertaken to understand the true benefits to cross-breeding. Uncertainty also remains in the frequency at which dogs need prophylaxis and could be another important area of study within the unit. Despite these uncertainties, the reduced number of cases in the cross-bred dogs has reduced costs of both prophylaxis and treatment, and reduced the time that dogs are on rest following a prophylaxis dose. Reduced prophylaxis also reduces the side effects of the dose, including swelling in the hind legs (injection site), limping or prolonged weakness in the legs, and occasionally high temperature.

Budget

The 2015 budget included funds to create a two-dog unit and support the necessary handlers and facilities, but creating a larger K-9 unit was prohibitively expensive at the time. However, the Howard G. Buffet Foundation made a generous donation of eight tracking dogs later that year. The donation included approximately 390,000 USD to build kennel facilities, hire and train 16 dog handlers, and cover operational costs for the first three years (Table 1). The foundation also donated a vehicle to be dedicated to the unit and funds to cover the operational costs of the vehicle (e.g. fuel, maintenance).

Following the initial three years, the K-9 unit budget has become part of Akagera's master budget which is funded from multiple sources. Park revenue contributed roughly 80% of the master budget in 2019, and funds from African parks, their donors, and the Rwanda Development Board covered the balance. Recently, funds secured through external grants have made significant contributions to maintaining the unit, especially in recent months as tourism has decreased because of COVID-19-related risks and restrictions.

The current five-year budget for the K-9 unit totals approximately 560,000 USD for 2020-2024 (Table 2). Yearly budgets for this time period average approximately 112,000 USD per year, accounting for 4% of the total master budget. Despite the average budget for the next five years being up slightly from the 2018-2019 average of 105,000 USD, the yearly K-9 unit budgets have remained similar each year with only minor fluctuations, despite significant changes in number of dogs and staff in the last five years (Table 2). Small year-to-year differences are the result of specific training costs that are incurred biennially and equipment replacement for some items done every two years. Major increases in cost, like doubling the number of dogs in the unit, have generally been balanced by large reductions in costs in other areas, such as reducing veterinary costs by creating an in-house clinic at park headquarters. The in-house clinic was created at no cost, but has accounted for important reductions in preventative and treatment expenses.

An existing room was used for the clinic and tables, desks, and shelving were appropriated from elsewhere at park headquarters. Microscopes and basic laboratory equipment (e.g. slides, sample tubes, stains) were donated by the Rwanda Development Board (estimated value around 9,000 USD). This generous donation allowed for expanded diagnostic abilities and follow-up. Veterinary supplies (e.g. drugs, prophylaxis) were already budgeted for as part of the yearly veterinary costs and preventatives. There were no costs of additional training as handlers had received training on basic first aid and there are refresher trainings covered yearly during general handler trainings. The team leader came to the unit with advanced training on basic laboratory practices. Visiting veterinarians in the park for other operations also contribute to capacity building and training at no extra cost.

Health issues related to trypanosomiasis are most common and previously required the dogs to be taken to the city for treatment. Treatment of trypanosomiasis in the city costs 310 USD per case in veterinary costs. This does not include the cost of fuel for transporting the dogs to Kigali, approximately 45 USD per trip, or potential costs incurred in Kigali (e.g. accommodation if trip is more than one day). Creating a small clinic at park headquarters has greatly reduced health-related costs (Fig. 1). Prophylaxis can be administered in-house at a cost of 3 USD per dose and cases can be treated for as little as 5.5 USD. Treatment in Kigali is the same treatment that is administered at the park. There are no additional tests or therapies done unless the dog has reached a chronic stage at which extra treatment would incur additional costs. The ability to also carryout minor procedures and care has reduced costs and contributed to an important, if small, reduction in budget. This has been a major success for the program and further capacity for preforming more advanced procedures and monitoring should be sought.

Dog equipment and supplies are problematic and expensive to source. Equipment, especially for working dogs (leads/leashes, collars, harnesses, etc.), is generally unavailable in Rwanda and needs to be imported. Stocking stores with replacement items of acceptable quality is expensive compared to other countries, but necessary to ensure wellbeing. Dog food is also expensive and difficult to obtain. Dogs are fed Royal Canin Maxi Adult dry pellet feed for large dogs (manufactured by Royal Canin, Aimargues, Lanquedoc-Roussillon-Midi-Pyrenees, France). Dry dog food often has to be shipped because of shortages and issues with availability of quality food. A single bag of food costs approximately 72 USD and lasts only two days. Dog food is consistently the most expensive budget item after staff salaries. Raw meat would provide a cheaper, more-available alternative but cannot be used for various reasons. If dogs grow accustomed to raw meat, poachers being pursued by dogs could toss meat aside as a distraction or to draw them off the track. Similarly, raw meat provides an easy opportunity for poachers to poison dogs. Furthermore, raw meat does not provide a balanced nutritional diet for working dogs (e.g. it is difficult to provide the correct balance of micronutrients with raw meat alone), carries a risk of food-borne illness for the animals (e.g. *Escherichia coli*, *Toxoplasma gondii*), and handling raw meat can be hazardous for people (e.g. S*almonella* spp. transmission; LeJeune & Hancock 2001, Lenz et al. 2009, Freeman et al. 2013). Dry food provides a balanced diet, is also easier and safer to keep and handle, and some dogs have been observed refusing to eat dry food after becoming accustomed to raw meat.

Costs can further be lowered by utilizing local or on-hand materials. Kennels were constructed using local labour and building material. The training area was built in whole using scrap materials like old tires, rope, and tubing. This significantly reduced the costs compared to buying these items new or pre-made. Additionally, routine maintenance and up-keep of facilities has kept running costs low. The investment in well-built facilities initially has greatly benefited the program budget-wise.

Operations

The current K-9 unit comprises 16 dogs, one unit supervisor, one team leader, one deputy team leader, and seven dog handlers. Two kennel attendants support health surveillance activities, cleaning, and feeding around the kennels, and one driver is available to take dogs and handlers to the field for operations or training.

Dogs begin training at six weeks old. All dogs train six days a week. The seventh day is reserved for rest and comprehensive well checks. Despite one litter of puppies being quite young still, they participate in all training and field exercises that the older dogs do and are not under any limit in

terms of training rigor, time, or style. Training combines exercises at park headquarters using obstacle courses and short tracks with longer tracks in the field. Training is implemented week to week by the unit supervisor and team leader. Dogs begin at the same point for each level of training but often progress at different rates. This can pose challenges for keeping the slower dogs on track. Similarly, illness and injuries can slow a dog's progression and make it difficult for them to catch up with their cohort. If individuals fall too far behind they may be dropped out if they fail to meet the standards. The tracking standards become more rigorous as the dogs progress, and tests them on tracks of different lengths and age, tracks in different terrains with challenging paths (e.g. 90 degree turns, U turns), and amount of time the dog can maintain a track. For example, one dog might be assessed on a track that is one hour old, includes a road crossing and a U turn, and should take 45 minutes to complete. If the dog is successful, the following-week's training may include more rigorous version of the same track or introduce new challenges. Currently, most standards within the unit focus on short-term success of passing a specific training objective. It may be beneficial in the future to also evaluate factors that contribute to long-term success as a working dog and longevity in the field. Understanding these may allow for better identification of and selection of animals to invest in from an earlier point, rather than removing dogs from active operations after extensive training. While all 16 dogs are tracking dogs, the unit benefits from a diversity of tracking techniques and abilities. Five dogs are qualified to track on-lead, and eight dogs are used for off-lead, pack tracking. The three remaining dogs have not met the qualifying standards for deployment to track humans and are currently used in a security role around park headquarters. These three animals are also going through training to be used as detection dogs for research purposes (e.g. locating animal scat and biological samples for collection).

One of the successes of training has been implementing off-lead tracking in addition to the conventional on-lead methods. This allows the dogs to work faster and longer because they do not tire as quickly as they would while being held back on-lead. Off-lead dogs can cover a distance that would normally take on-lead dogs six to eight minutes to cover in one minute. Recovery time is less following a track, and operations can be extended much longer than for on-lead dogs if needed. Two or three dogs work together during off-lead tracking which builds team-work and cohesion. The unit is still in the training phase for this type of tracking, but most dogs have shown high competency in simulated exercises.

The intensive training schedule is in-part due to lack of work. Law enforcement activities, technology, and community initiatives have expanded so much in the past ten years that they have effectively reduced the number of poachers in Akagera. Detection of poachers and snares has improved, as has apprehension. Because of this, it is challenging to deploy the K-9 unit on live operations. The typical rate of reactive patrol deployment in response to poacher detection is once every three months. The dogs are used on general patrol two to three times per month as well, but the majority of their activity is training exercises. This poses challenges for keeping the dogs fit for operation and requires special regimens to simulate live operations to keep dogs fit and sharp. One benefit of much of the training being done in the field is that it functions like a patrol and does increase coverage of law enforcement activities. General patrols with the dogs are planned to be increased to four to six times per month as well.

An external trainer is brought from South Africa three times a year for a week-long visit. The external trainer works with the dogs directly and with the handlers. The unit supervisor and team leaders are additionally instructed on skills and methods for continuing training and teaching the other handlers. The external trainer is responsible for bringing new techniques and skills to the unit. Having individuals that may approach challenges in new and creative ways or bring techniques that are more advanced than what the unit can currently manage is key for increasing capacity and expanding knowledge within the unit. This contributes strongly to consistent and effective dogs and detail-oriented handlers. These trainings reiterate the importance of handlers building strong relationships with their dogs and expanding their expertise to grow the capabilities of teams in the field. Trainings have proven key to keeping handlers and dogs motivated, and handlers rate these trainings as important and beneficial.

Maintaining such a large unit is expensive when there are minimal opportunities to deploy the dogs in live operations. With the recent management

acquisition of Nyungwe Forest National Park in southern Rwanda by African Parks, four to six dogs will hopefully be transferred there for work. This will reduce costs and provide field-ready dogs to a park that currently does not utilize them in counter-poaching operations. Six to eight working dogs is likely the optimal number for Akagera both budget-wise and operationally. A reduced number of dogs with varied capabilities will cover the needs of the park and allow handlers to work more closely with a few animals. This may strengthen the dog-handler relationships and could have positive consequences for cohesion and efficacy within the unit. An eight-dog unit will potentially be achieved in the near future because of the transfer and multiple dogs nearing retirement. However, even retired dogs may pose a financial challenge as they will likely remain in the unit despite not working as finding good homes to take them in is challenging.

Transportation has proven a demanding problem. While a vehicle was donated for dedicated use by the K-9 unit, it eventually began to be used for other law enforcement activities as well. In time, this necessitated the conversion of an old vehicle into the new K-9 vehicle. Without transportation readily available, the unit cannot be effective in responding quickly to developing situations. Despite few opportunities to deploy dogs, the vehicle allows for continued training in live-operation-like situations that ensure dogs remain fit and ready for action. Communication is also critical for a fast response should the need arise. In situations where the dogs have been deployed efficiently in response to poacher detection, clear and fast communication through the appropriate channels has facilitated this response. However, there have been some cases when the K-9 unit should have been deployed but lack of communication, unpreparedness, and a shortfall in logistics prevented their use. Because personnel and resources are limited, and often overlap between K-9 unit operations and other law enforcement activities, communication and planning are critical. Improvements in both have made dog work and standard patrols more compatible and renewed commitments to following standard operating procedures in response to urgent situations has greatly reduced reaction times. Having personnel and vehicles dedicated to standby and rapid response has improved preparedness and reaction operations.

Recommendations

Akagera's K-9 unit has shown positive growth and development since its conception. Numerous difficulties have been addressed, and some continue to be prevalent, but all have contributed to important changes and learning opportunities that have allowed the program to progress. Multiple recommendations can be made following this examination of the unit. These recommendations should continue to inform the best practices and development of the K-9 unit at Akagera, but are also intended to be general enough that new and established programs elsewhere in rural Africa may benefit from the experiences in Akagera.

Team leaders, handlers, and kennel staff should all have basic veterinary and first aid training to be able to recognize and treat common illness and injury, and an on-site clinic should be created and stocked. This creates a safer environment for the dogs and reduces potential risks of having to move a dog to the city for treatment when they could be treated in-house. This considerably reduces costs. An evacuation plan should still be in place for unknown or severe illness and injury.

Early results suggest there may be some potential health benefits from cross-breeding local dogs with dogs from Europe, including cross-bred dogs possibly being more suited for work in the African bush. This recommendation will require further evaluation following the birth of additional litters of puppies and is not necessarily urgent, especially where, for example, other options for protecting dogs against tsetse flies in the kennels and in the field are available. Further research and long-term monitoring is required to draw any conclusions. Future studies should be conducted to better understand this topic.

Well-constructed facilities and high-quality equipment, dog food, and supplies are critical for maintaining the health and well-being of the dogs. Despite high costs of importing some items not available in country, this is a necessary part of the budget and short-cutting these aspects could lead to physical, nutritional, and stress-related problems for the dogs. Where local alternatives meet the standards for quality, these options should be utilized, which can greatly reduce cost, is often more sustainable, but must only be considered if there is no compromise to the well-being of the dogs.

Routine training for both dogs and handlers is important. Especially in areas where live operations are few, training in simulated scenarios will keep dogs fit, engaged, and ready for reactive patrols should the need arise. Dogs should not be left sedentary in the absence of work. Similarly, general patrols can support fitness and focus for both dogs and handlers, and contribute to the greater law enforcement effort in a meaningful way. Training also maintains the strong bonds between dogs and handlers.

External trainers should be contracted yearly for refresher courses for dogs and handlers, and to train team leaders to improve their teaching skills and expertise. New techniques should be learned and implemented to avoid monotony and stagnation that can lead to lowered moral and efficacy. The training process is important to maintaining close bonds and promoting physical and mental fitness of both dogs and handlers.

A canine unit with multiple capacities is key to being prepared for any situation that may arise. Akagera's K-9 unit comprises dogs that can track humans both on-lead and off-lead. Multiple dogs are also being trained to track wildlife and their sign. A unit with multiple skills can deploy the appropriate dogs to any situation without having to compromise efficiency or put dogs and handlers at risk by trying to force a narrow set of skills to a particular circumstance.

Cooperation and communication between the canine unit and other arms of management and law enforcement is critical. This is especially important where resources, personnel, and equipment may overlap and are limited. Common goals and plans to reach them must be understood. Day–to-day logistics and emergency responses need to be clear and synchronized. Without this clarity, the unit cannot be deployed effectively to combat poachers as intended.

Most importantly, handlers most be motivated and dedicated to their dogs. A strong relationship is critical for getting the most out of the dog in a safe and productive way. That relationship is reciprocated to the handler by the dog and positive strong relationships will increase the strength and drive of the unit as a whole.

If all of these aspects can be met and maintained there is a high chance of success for a unit. Diligence and commitment are required to keep standards high and programs moving forward. If these can be met, working dogs have an opportunity to contribute meaningfully to the conservation goals of management organizations.

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