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ARTICLE

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Modified netting technique for capturing gazelles in Serengeti, Ngorongoro and Loliondo, Tanzania

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Abstract

During serological surveillance of peste des petits ruminants (PPR) disease, it required capture of randomly selected herds of gazelles as part of a study to determine the epidemiological role of these species in the circulation of peste des petits ruminants virus (PPRV). The study targeted capturing 135 Grant's gazelles (***Gazella granti***) from the Serengeti ecosystem, Tanzania. A modified netting technique was used aiming at providing safe, efficient and cost-effective method for capture of gazelles. Locally available materials were used, and wildlife professionals guided the process of manufacturing supporting frame for the nets. Twenty (20) black metal pipes, 20 metal bars, four nets and three vehicles were used in the procedure. A total of 136 Grant's gazelles and nine Thomson's gazelles were captured in three missions. The Grant's gazelles were captured as per sample size calculated in all locations: Loliondo (n = 25), Serengeti National Park (n = 44) and Ngorongoro Conservation Area (NCA) (n = 67) using less time and minimum cost than estimated. Injuries of three fawns (2%) inadvertently captured with the groups of adults and sub-adult animals were recorded. Comparing with 2014 and other studies, modified netting technique showed high animal and operator safety levels with minimal injuries. With this technique, it was possible to capture even flighty animals that behave nervously because of hunting and other human activities, including Thomson's gazelles, a species previously found to be difficult to capture by netting.Keywords

capture, disease surveillance, gazelles, netting, Tanzania

Résumé

Lors de la surveillance sérologique de la peste des petits ruminants (PPR), il a fallu capturer des troupeaux de gazelles sélectionnés au hasard dans le cadre d'une étude visant à déterminer le rôle épidémiologique de ces espèces dans la circulation du virus de la peste des petits ruminants (VPPR). L'étude visait à capturer 135 gazelles de Grant (*Gazella granti*) présentes dans l'écosystème du parc national du Serengeti, en Tanzanie. Une technique modifiée de capture par filets a été utilisée dans le but d'assurer une méthode sûre, efficace et économique pour la capture des gazelles.

Des matériaux disponibles localement ont été utilisés et des experts de la faune ont guidé le processus de fabrication du cadre porteur des filets. Vingt (20) tuyaux en métal noir, 20 barres métalliques, quatre filets et trois véhicules ont été utilisés dans le cadre de la procédure. Au total, 136 gazelles de Grant et neuf gazelles de Thomson ont été capturées au cours de trois missions. Les gazelles de Grant ont été capturées selon la taille de l'échantillon calculée sur tous sites; Loliondo (n = 25), parc national du Serengeti (n = 44) et la zone de conservation du Ngorongoro (NCA) (n = 67) en moins de temps et pour un coût minimum moins élevé que prévu. Trois faons (2%) capturés par inadvertance avec les groupes d'animaux adultes et subadultes ont été blessés. En comparaison avec l'année 2014 et d'autres études, la technique modifiée de capture par filet a démontré des niveaux élevés de sécurité pour les animaux et les opérateurs avec un nombre minimal de blessures enregistré. Grâce à cette technique, il a même été possible de capturer des animaux instables qui se comportent nerveusement en raison de la chasse et d'autres activités humaines, notamment des gazelles de Thomson, une espèce auparavant difficile à capturer au filet.

1 | INTRODUCTION

The capture of free-ranging wildlife has always been a difficult but necessary part of population management, animal monitoring through marking or radio collaring for remote sensing, disease investigation, relocation and many other conservation practices (Gehr, 2010; Webb et al., 1996). There has been advancement in capture and handling methods to minimise the amount of stress imposed on animals and to reduce the risk of mortality at the time of capture. It is extremely important that the best practices are known, published and used for ethical and welfare reasons (Mmmalogists, 1998). This will assist in achieving objectives in an efficient, cost-effective manner and minimise mortality in the management of rare, threatened or endangered species of wildlife. Methods used for physical capture are reported elsewhere (Farst & Fowler, 2010; Ferreira, 2016; Gehr, 2010; Lekolool, 2012; Locke et al., 2004; Denicola et al., 2000; Webb et al., 1996) , reviewed in texts (Laubscher et al., 2015) and developed into training and field manuals (Kock et al., 2012) .

There are relatively few reports of netting gazelles in East Africa with exception of Kenya Wildlife Services (KWS) internal reports (KWS 1996; R. Kock, personal communication, 2019). In Kenya, in the 1990s, on the plains between Longonot and Suswa Volcanoes in the Rift Valley, over one hundred Thomson's gazelles (*Eudorcas thomsonii*) were caught through a simple drive chasing using over 200 m of extended short cotton nets. These were captured successfully for translocation to the Middle East (KWS 1996; Kock, personal communication 2019). In Ngorongoro district of Tanzania, in 2014 and 2015, 27 Grant's gazelles (*Nanger granti*) and one Thomson's gazelle (*Eudorcas thomsonii*) were netted in an earlier phase of peste des petits ruminants (PPR) research in the region. The research aimed at investigating the spillover of the PPR virus from goats and sheep co-existing with these species through serological surveillance. These animals were netted by using a combination of a net boma (fixed perimeter with gum poles) and internal drop nets (Cape Netting PLC RSA nylon cotton rope net 30 m × 3 m × 150 mm mesh × 4 mm Tex Pes Br. and 50 m × 3 m × 150 mm square mesh × 5 mm Tex Pes Br.). This technique was used successfully with no injuries or mortalities (Mahapatra et al., 2015; Parida, 2017). One constraint of this method was the time and effort in setting up the system which usually resulted in only one attempt at capture per day. The initial research was extended to include a much larger sample size across a larger landscape in order to achieve key objectives of the PPR research for improved understanding of the PPR virus epidemiology. This required capture of randomly selected herds of gazelles as part of a study to determine the epidemiological role of these species in the circulation of peste des petits ruminants virus (PPRV). The number of animals to be captured was calculated on a statistical basis to ensure the minimum interventions to achieve significance in the analysis. This is essential data for ensuring the eradication strategy of PPR in the region takes into account the role of wildlife in persistence of the disease. Therefore, a budget for chemical immobilisation and netting were prepared by Tanzania Wildlife research institute (TAWIRI). The two methods were compared on different aspects. However, netting was again applied in 2019 with modifications. Previous experience in the region and reference to literature were used as a basis for designing a capture technique for disease surveillance in the Serengeti ecosystem over the period 2014–2019. One hundred and thirty-six (136) Grant's gazelles were captured from 27 sites in the Greater Serengeti ecosystem, inside and outside of wildlife protected areas. This also included opportunistic capture of nine Thomson's gazelles, a notoriously difficult species to capture using mobile net systems. A modified

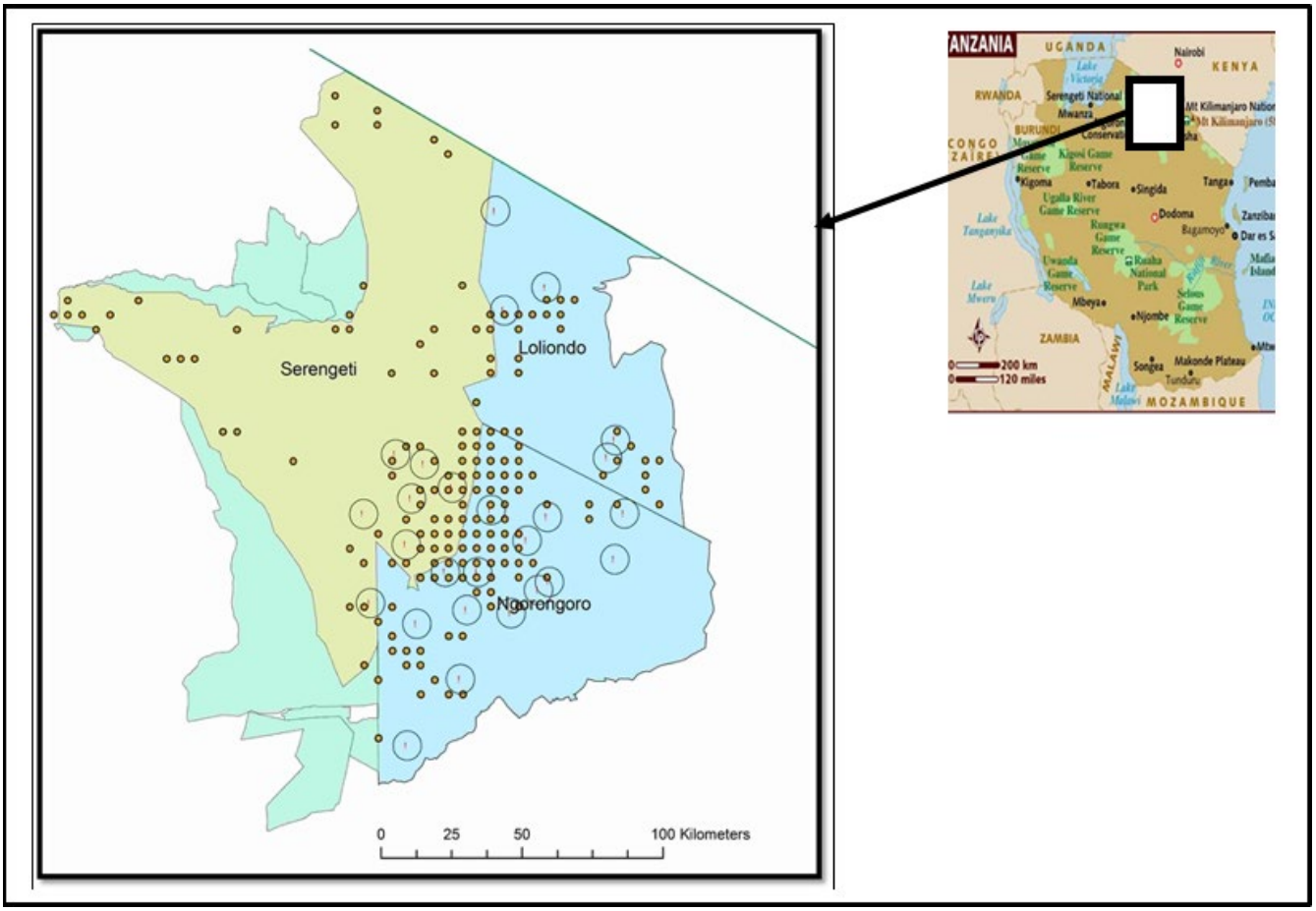

FIGURE 1 Map showing greater Serengeti Ecosystem and distribution of Grant's gazelles (*Nanger granti*) (small circles) in Serengeti, Ngorongoro and Loliondo, and locations where sampled Grant's were captured (larger circles) [Colour figure can be viewed at wileyonlinelibrary.com]

netting method used for capture of these species of gazelles, for interventions and health surveys is reported here. Although large-scale capture of blesbok (*Damaliscus pygargus phillipsi*), springbok (*Antidorcas marsupialis*), oribi (*Ourebia ourebi*), impala (*Aepyceros melampus*) and tsessebe (*Damaliscus lunatus*) has been reported (Laubscher et al., 2015) and their associated mortalities documented (Hofmeyr et al., 1976), the scale of safe capture of Grant's gazelle (*Nanger granti*) undertaken is unprecedented, to the author's knowledge.

2 | MATERIALS AND METHODS

2.1 | Study area

The study was carried out in the greater Serengeti ecosystem which comprises of Serengeti National Park (SNP), Ngorongoro Conservation Area Authority (NCAA) and Loliondo Game controlled Area (LGCA) (Figure 1). These areas are in Ngorongoro district, Arusha region and Serengeti district in Mara region; all found in northern Tanzania. A greater part of this area is a conserved area with areas strictly for wildlife (SNP), and others with multiple land use where wildlife co-exist with livestock (NCAA and LGCA).

2.2 | Materials

- Black pipes—ordinary round metal pipes used in households for gas lines and other appliances in Tanzania (22 mm diameter).
- Furniture pipes—softer metal pipes available in Tanzania (22 mm diameter)
- Iron bars 70 m (22 m diameter)—round metals used in construction, pointed on one end for easy ground pinning by hammer.

FIGURE 2 Picture showing netting structure with pipes inserted into ground pinned metal bars and hanging nets [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE 3 Picture showing vehicles herding gazelles towards the netting system [Colour figure can be viewed at wileyonlinelibrary.com]

- Animal capture nets
- Hammer for ground pinning of the iron bars
- Three vehicles (two station wagons and one pick up)

2.3 | Modified netting method

The framework for the nets was manufactured by local Tanzanian technicians using locally available materials. Materials used included (a) 20 pieces (pcs) of metal pipes measuring 3 metre (m) tall and 22 mm in diameter. The pipes had hooks welded 8 cm from both ends holding nets which allow rapid dropping of the net upon impact on the net by running animals chased by vehicles. (b) 20 pcs of iron bars measuring 70 cm long, 22 mm in diameter with one sharp end, ground pinned half way using a hammer at an interval of 10 n . The hooked metal pipes were inserted into the other half of ground pinned metal bars. (c) 50 m long and 3 m wide nets (Cape Netting PLC RSA nylon cotton rope net measuring 50 m × 3 m × 150 mm square mesh × 5 mm Tex Pes Br) hanged on the metal pipes hooks. The pipes were inserted into the iron bars to make a half-mooned shape-netting trap (Figure 2). Usually, four nets were used and their placement was designed to make escape difficult once the gazelles were herded to within 100 m of the net configuration. The nets were sited in areas where vehicles could move freely without excessive bush or ground obstacles. Once a group of gazelles was identified, three vehicles positioned in a V shaped manner gently pushed them towards the netting site from a distance of between 150 and 200 m (Figure 3).

On average the netting system had a diameter of 100 m. At the beginning of this work, furniture pipes were used exclusively; however later, these were changed because it was found that the furniture pipes were bending when bigger male Grant's gazelles bounced into the net. Thereafter, black pipes were used alternately with furniture pipes. Each of the two station wagons used had five personnel at a time, whereas the pickup had two personnel. After completion of activities, the pickup was also used to carry the netting system from one point to the other. During this work, most of the time was spent for travelling and logistics. On arrival at a sampling point, communications were made with the resident wildlife protection authority. They provided one or two officers to accompany the team to ensure that safety and welfare of animals were observed on each sampling site.

During each capture round, small groups of Grant's gazelles, 6–20 in number, were approached by the three vehicles, with the first vehicle in line with one end of the net system, the second vehicle on the other end and the third vehicle positioned in the middle and slightly behind the other two, displaying a shape resembling the horns of a buffalo (Figure 4). For the first 3–5 min, animals were pushed slowly at a speed between 30 and 40 kilometres (km) per hour (hr) towards the centre of the net system. When about 100 to 150 m from the entrance to the netting system the coordinating vehicle signalled to increase the speed up to 120–140 km/hr driving the gazelles into the net. This high speed was possible because the setting of nets considered areas with good terrain where a car could drive smoothly. This manoeuvre distracts the animals from the presence of the net and in a panic, they usually enter and hit the net, becoming safely entangled. The vehicles immediately stopped once the animals hit the nets and

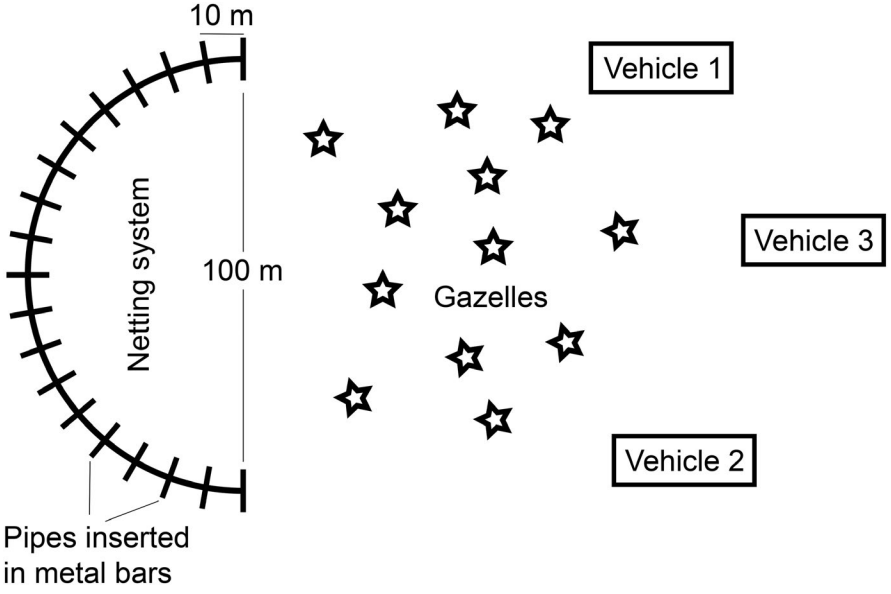

FIGURE 4 Picture showing netting system, vehicles and Grant's gazelles positioning during capture

TABLE 1 Location, age and sex of Grant's and Thomson's gazelles captured and sampled

	Grant's and Thomson's gazelles captured, age category and sex								
	Aged		Adult		Sub-adult		Young		
Location	Male	Female	Male	Female	Male	Female	Male	Female	Total
Loliondo	0		2	13	5	4	0	2	26
NCAA	0		23	30	6	8	5	3	75
Serengeti NP	0	2	18	20	1	3	0	0	44
Total	2		106		27		10		145

the capture team left the vehicles and safely restrained the entangled animals, whilst ensuring that they could breathe effectively and had no rope restrictions that could cause injury to the head, neck, legs or body. Thereafter, sampling equipment was brought and sample collection conducted. Sampling started with larger animals as it is much more difficult to restrain them for a prolonged time. Restraining of aggressive animals involved more than one person. Normal tranquilisers could be administered (Hofmeyr et al., 1976), but in this case, these were not used as the protocol was for immediate release after sampling and this avoids any higher risk of predation from longer term effects of tranquilisers. When the animal was stable and secure, the biological sampling team accessed the jugular vein to collect blood, obtained faecal samples from the rectum, ectoparasites and eye, nasal and oral swabs. After collection of samples, and movement of majority of the team to a safe distance, the animal was freed from the net, whilst holding the horns firmly and keeping the animal recumbent, pointing away from the net trap followed by release. On doing so, it helped to minimise injuries to animals and personnel. One animal was sampled after the other. After completion of the sampling activity, all the collected samples were labelled and stored. The period from capture to release of all the animals in the net was between 3 and 30 min depending on the group size captured. The mean time from capture and sampling to release was 17 ± 9.9. The animals were monitored for injury and mortalities for up to 8 hrs post-capture. Subsequent monitoring of the animals was done by Rangers and Maasai herdsmen residing in the area, for up to a week.

3 | RESULTS

A total of 136 Grant's and nine Thomson's gazelles were captured during the project period in three missions with an average of 18 days per mission. Evaluation of the age and sex of the animals captured by the modified net capture method shows that adult and female animals were mostly captured (Table 1). This demonstrates the behaviour of these animals in their natural habitat where adult females are in large numbers in their herds. Among the captured gazelles were three fawns which sustained hip dislocation (<2% injury rate). The fawns were inadvertently captured with the herd as separating them from adults proved problematic. These were euthanised using a recommended method described previously (Shearer & Ramirez, 2013). In numbers, the captured Grant's gazelles were 25, 44 and 67 in Loliondo, Serengeti and NCAA respectively. Of the nine-captured Thomson's gazelles, one was from Loliondo and eight from NCAA. Table 1 displays location, age category and sex of Grant's and Thomson's gazelles captured and sampled for PPR study. Table 2 displays results of comparison of the new modified technique and other adopted techniques in wildlife capture, the comparison includes four items.

TABLE 2 Method of capture and cost in finance, labour, restraint period and injury risk

S/N	Method	Cost	Person days	Rate of injury	Restraint period
1.	Net bomas	40,448	600	2%	5 min
2.	Modified Net method	20,224	300	2%	5 min
3.	Darting	54,852	287	10%	15 min

4 | DISCUSSION

Netting has become a preferred method of live capture for biologists and wildlife managers around the world when working with small to medium ungulates and some other species, due to its relatively low cost and the ability to capture larger groups of animals (Kock et al., 2012; Laubscher et al., 2015). The modified boma netting technique used in this study was an improvement on the previous operation that used a boma and drop nets when capturing a smaller number of gazelles in Ngorongoro district in the years 2014 and 2015.

There are limited reports evaluating the effectiveness of different capture methods on gazelles. Comparing with the previous methods used to capture the gazelles in these localities; the new capture method has shown improvements on aspects of efficiency, cost and safety. In the study area, each location had a calculated sample size, time allocated to accomplish capture as well as a budget which was estimated based on previous experience with different methods. With a modified netting technique, the number of animals required per location was captured in a shorter time and using a much lower budget with minimum injuries and without mortalities associated with the capture; compared with a study by Kock et al. (1987). Unlike modified netting technique where injuries were recorded only to the

fawns, previous methods (the net gun, drop net, drive net and chemical immobilisation) recorded injuries, capture myopathy mortalities and accidental mortalities (Kock et al., 1987). With this technique, managers can work safely and efficiently but it is always appropriate to have veterinary staff on hand to deal with occasional injuries and to ensure the physical welfare of the animals as insisted in different studies that fear, pain, suffering and distress should be kept to a minimum (Fowler, 2003).

The modified netting technique was found to be an excellent capture technique in the rangelands of Serengeti National Park, Ngorongoro Conservation Authority and Loliondo Game Controlled areas. The main benefit of the new method was a reduction in the time spent in preparation of the capture system when compared with the previous attempts that adopted other techniques. The method proved to be equally effective with a single net line and without the use of internal drop nets, which is not the case with net boma technique. Using the modified technique the team was also able to capture Thomson's gazelles, a species that proved to be very difficult to capture in previous attempts in 2014–2015 with the use of conventional netting techniques. The Thomson's gazelles are relatively more difficult to net because of their ability to change direction of run rapidly and efficiently, avoiding capture even when running at full flight.

Ordinary netting techniques have been associated with several drawbacks. Some authors have reported limitation in use of the techniques in certain environmental conditions; and that their safety and effectiveness is not guaranteed (Sahu et al., 2017; Denicola et al., 2000; Webb et al., 1996). Authors in South Africa have associated the techniques with mortalities of the captured animals (Laubscher et al., 2015). Comparatively, the modified technique is considered to be as safe and effective in wildlife capture as the net-gun technique reported by Webb et al. (1996). However, in low-income countries, the net gun is considered costly and needs other sophisticated expertise and equipment which are not always readily available.

Comparatively, the developed technique is much more effective in terms of time and financial resources than chemical immobilisation methods which have an added disadvantage of using highly restricted and expensive drugs, and require specialist operators who are qualified veterinarians. The current cost of immobilisation chemicals for the reported number of sampled Grant's gazelles was estimated at 20 million Tanzanian shillings ($10,000) which includes cost for 10 bottles of etorphine at a concentration of 9.8 mg/ml (5 ml vials), miscellaneous sedatives, tranquilisers and antidotes; compared to 1.1 million Tanzanian shillings ($ 500) used to purchase and manufacture the netting frame used to capture gazelles by netting. For immobilisation, the budget could have been slightly low, only if almost every dart used reached the target (>98% success rate). However, darting small ruminant species is a practical challenge in cases where the flight distance is high. With gazelle species, it is not common that the darting success rate would be above an average of 30% in these conditions. In addition, the time required for fieldwork would be long, with probably a maximum of four animals per day adding further to staff costs (37 staff days immobilising versus 25 staff days netting). In addition, it is usually only feasible to dart one animal from a herd at one time and each herd is widely dispersed in this ecosystem, adding to the extra cost of vehicle fuel. Setting the net boma to capture the animals took about 2 hrs and on average seven Grant's gazelles were captured per site. The estimated cost per Grant's gazelle capture is about Tanzanian shilling 217,000 ($103) using four people for capture and sampling. Additionally, chasing of animals for immobilisation leads to extended flight during which they can either be injured or killed by inappropriate dart location on the body or suffer capture myopathy from excessive physical stress and heat. Although chasing is a component of netting too, it tends to be for a much shorter period, not physiologically very different from being chased by a predator, which normally happens almost daily with these species.

The modified net capture technique was found to be reliable for Grant's gazelle, and proved practical for Thomson's gazelles of all ages in a variety of locations in Tanzania where vehicle access was feasible. This technique proved to be safe for the operators and for the captured adult and sub-adult gazelles. The injuries observed in fawns underscore the need of avoiding inadvertently accessing fawns during wildlife capture. Although this method proved to be effective in the current environment, it may need modification in other habitats and with other species.

5 | CONCLUSIONS

Adult and sub-adult Thomson's and Grant's gazelles of both sexes can be successfully captured using the modified netting system in a variety of accessible locations in Tanzania. The system operates at a relatively lower cost and works safely when compared to chemical capture methods.

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CONFLICT OF INTEREST

The authors would like to declare that they have no conflict of interest in the study.

ETHICAL APPROVAL

Note the ethics approval number: URN 2017 1741–3 —Project Title: Pathway to peste des petits ruminants virus elimination – methods

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DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

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