Review article

Non-chemical techniques used for the capture and relocation of wildlife in South Africa

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Annually, thousands of game animals are captured and relocated across South Africa. One of the biggest causes of mortality during these translocations is stress, and as such it is the responsibility of all stakeholders involved to ensure that appropriate techniques are applied for specific species and environments. It is therefore important that there is a thorough understanding of these methods not only from a management perspective but also in terms of applied animal welfare. This review provides detailed descriptions of the various non-chemical techniques that may be employed during game capture and relocation in a South African context and highlights both species suitability, as well as the advantages and disadvantages of each technique. It also gives a brief background to the South African game capture industry as well as discussing and giving guidelines for the transportation and holding of wildlife after capture.

Key words: wildlife, capture, translocation, South Africa, animal welfare.

INTRODUCTION

With the growing annual turnover from wildlife sales in South Africa, there has been an accompanying increase in the demand for wildlife translocation across the country (The National Agricultural Marketing Council, 2006; Dry, 2010; Saayman, Van der Merwe & Rossouw, 2011; Van Hoving, 2011; Steyn, 2012). Concurrently, there has been an increase in concern for the welfare of the animals and the minimization of financial losses due to stress-related mortalities and injuries (Read, Caulkett & McCallister, 2000). The scope of this review aims to highlight and disseminate the use of various wildlife translocation practices in the South African context. It is specifically focused on non-chemical capture techniques and the handling and transport of animals after capture. For the purpose of this review, the use of chemical immobilization and sedation has been excluded.

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AN OVERVIEW OF THE LIVE GAME TRADE IN SOUTH AFRICA

The wildlife ranching industry in South Africa (consisting of both private and national parks) comprises more than 20% of South Africa's total land, utilizing almost a third of the country's potential grazing land for wildlife and wildlife-related purposes (Cloete, Taljaard & Grové, 2007). Most wildlife ranches make use of both restocking of animal populations as well as off-take (either in the form of hunting, capture for live sale or harvesting) in order to prevent overpopulation (Muir-Leresche & Nelson, 2000; Higginbottom & King, 2006). The trade of live animals has become a significant part of the wildlife industry and meets both the objectives of removing surplus animals and raising revenue (Muir-Leresche & Nelson, 2000; Higginbottom & King, 2006). Prior to 2006, it was estimated that around 70 000 animals were translocated annually (The National Agricultural Marketing Council, 2006), but in 2010 alone, an estimated 167 400 head of wildlife were reported as having been

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translocated across the country (Dry, 2012). According to the Wildlife Translocation Association, there are currently between 80 and 100 wildlife capture operators in South Africa that move over 300 000 head of game per year (Dugmore, 2013). Both private owners and government conservation agencies buy and sell live animals, principally through auctions, transactions through agents, or private transactions (Higginbottom & King, 2006).

The live trade of wildlife in South Africa is limited principally to larger mammals that are considered valuable interms of hunting, tourism and meat production (Higginbottom & King, 2006). These include common species such as impala (*Aepyceros melampus*), blesbok (*Damaliscus phillipsi*), springbok (*Antidorcas marsupialis*), blue wildebeest (*Connochaetes taurinus*) and eland (*Tragelaphus oryx*) as well as rare species such as disease-free buffalo (*Syncerus caffer*), sable antelope (*Hippotragus niger*), white rhinoceros (*Ceratotherium simum*), Livingstone's eland (*Tragelaphus oryx livingstonii*) and nyala (*Tragelaphus angasii*) (The National Agricultural Marketing Council, 2006; Van Hoving, 2011). Steyn (2012) published an article on the profitability of the wildlife trade in South Africa and why the sale of live animals has become so popular. Steyn (2012) remarked on the contribution of tourism, hunting and rare-game breeding and noted that rare-game breeding has become an increasingly popular investment choice for savvy business people who previously had not invested in this industry.

THE HISTORY OF WILDLIFE TRANSLOCATION TECHNIQUES IN SOUTH AFRICA

The translocation of wildlife is done for a number of reasons, including population management, species introductions and reintroductions, research and monitoring, population health evaluations, and the habituation of injured or orphaned animals to captivity (IUCN Council, 1987; Lekolool, 2012). Initially, game capture methods included the use of dogs (*Canis lupus familiaris*) to ambush and drive frightened animals into pits or snares as well as chasing animals by vehicle and capturing them using a noose (referred to as the 'catch-and-rope' method) – methods which resulted in high mortalities and injuries (Carruthers, 2008; Lekolool, 2012). It was not until the work of A. Harthoorn in Uganda and I. Hofmeyr and H. Ebedes in Namibia that the use of tranquillizing and immobilizing drugs in the translocation of wildlife became an integral part of the wildlife industry (Carruthers, 2008). Historically, the capture of surplus animals in the Umfolozi, Hluhluwe (now Hluhluwe-iMfolozi) and Mkuze reserves was the beginning of the development of various capture techniques (Oelofse, 2010). By 1968, different capture and relocation methods were being compared in an effort to improve the whole process (Visagie, 1968; Carruthers, 2008). In 1973, the milestone publication of the book '*The capture and care of wild animals*' by Eddie Young, gave some of the first guidelines (based on comparative research and experience) on how to effectively capture and relocate wild animals in Africa (Young & Ebedes, 1973). Thereafter, numerous other books and publications have provided the basis for the effective capture and relocation of wildlife by minimizing danger to both animals and personnel (McKenzie, 1993; La Grange, 2006; Kock & Burroughs, 2012; Kreeger & Arnemo, 2012). Techniques for the administration of tranquillizing and immobilization drugs as well as different combinations of drugs were also being investigated at this time although this field was still relatively new in South Africa in the 1980s (Van Niekerk & Pienaar, 1962).

Wildlife translocation in South Africa involves a number of role players including private sector capture teams, South African National Parks (SANParks), provincial capture teams, wildlife veterinarians as well as wildlife ranchers (The National Agricultural Marketing Council, 2006). In the early 1990s, the Wildlife Translocation Association (WTA) was established to bring together all of these role players and to raise the national standards of wildlife translocations (Higginbottom & King, 2006; The National Agricultural Marketing Council, 2006). Membership is voluntary, although anyone who wishes to tender for government or big business contracts must be a member and all members must adhere to the WTA's code of conduct with special reference to animal welfare standards (Higginbottom & King, 2006; The National Agricultural Marketing Council, 2006).

CAPTURE AND HANDLING TECHNIQUES NOT INVOLVING CHEMICAL IMMOBILIZATION

Capture methods that are commonly used today include chemical immobilization, traps and cages, drop-nets, net bomas, net guns, plastic bomas and passive capture sites. The choice of a particular method will be dependent on a number of factors, such as species, reason for restraint, number of individuals to be captured, availability of appropriate drugs and equipment as well as personnel (Lekolool, 2012). For the purpose of this review, only the methods not involving chemical immobilization will be discussed as these methods may be employed without the supervision of a registered veterinarian if no scheduled drugs are to be used.

Traps and cages

Traps and cages are often used for species that are difficult to approach and are generally suited for species such as hippopotamus (*Hippopotamus amphibius*), predators, crocodiles (*Crocodylus niloticus*) and birds of prey (Grobler & Turner, 2010; Wolter, Neser & Hirschauer, 2014). A number of different traps can be employed, depending on the species with some of the more popular traps including box or cage traps and foot-hold (or gin) traps (Brand, 1993). Box traps are used for the capture of smaller mammals while cage traps are generally used for the capture of carnivore species such as honey badgers (*Mellivora capensis*) and felids (Herbst & Mills, 2010). Clover traps are larger and are generally made from a metal pipe frame, covered with diamond mesh. They are used for larger species with newer designs being collapsible. They may also be used at passive capture sites where the traps are left unmanned and animals are baited into the trap where they then hit a trip wire (Haulton, Porter, Rudolph, Haulton & Rudolph, 2001; Boesch *et al.*, 2011; Kock & Burroughs, 2012). All traps are usually designed to be twice the size of the animal with a framework that is covered with suitable wire mesh (Lekolool, 2012). Diamond mesh (also known as chain link) is often preferred over welded mesh as the latter is a more rigid material and may cause injury to the animal if it collides with it (Wolter *et al.*, 2014). Bait is attached to a trigger system which, when activated, causes a drop door or spring-loaded door to close, trapping the animal inside (Kock & Burroughs, 2012). Box and cage traps are not without their disadvantages and depending on the scenarios, animals can seriously injure themselves or die in a cage trap. Some issues influencing this include the trap design, construction material, how the trap is set, response time to engage with trapped animal, trap location (*e.g.* exposure to the sun), and the manner in which the trap is approached (The Cape Leopard Trust, 2012). With larger predators such as lions (*Panthera leo*) and leopards (*P. pardus*), animals are often reluctant to enter the trap unless it is baited with its own kill and captured animals sometimes destroy their claws and canines trying to get out (Frank, Simpson & Woodroffe, 2003). It is therefore crucial that these traps are monitored on a regular basis. Alternatively, a system can be used that links an electronic device to the trap so that it sends off a signal as soon as the trap has been sprung.

Foot-hold traps can be used for predator species such as jackal (*Canis* spp.), lion and African wildcats (*Felis silvestris lybica*) and can be modified (padded) to make capture as humane as possible (Brand, 1993). Foot-hold traps have been shown to be efficient in capturing wary lions where traditional methods such as cage traps, and free darting may be ineffective (Frank *et al.*, 2003). A foot-hold trap should not be confused with the conventional crude wire snares that are illegally used for bush meat. Instead, they are highly modified, highly specialized and are often regarded as the safest, most humane, and most effective capture technique for large felids (Gannon & Sikes, 2007; The Cape Leopard Trust, 2012). These traps are usually double-jaw spring-operated steel traps, which shut to clasp the limb of the animal. When the foot is placed in the centre of the trap, it depresses the trigger plate and releases the trigger mechanism (Kock & Burroughs, 2012). Their use should however be approached cautiously because of the potential for injury or the capture of non-target species (Kuehn *et al.*, 1986; Gannon & Sikes, 2007). Traps must always be of sufficient size and strength to hold the animal firmly and rubber padding or offset jaws should be used to minimize potential damage to bone and soft tissue. Foot-hold traps must be checked frequently (perhaps twice daily or more often depending on the target species and the potential for capture of non-target species) and captured animals assessed carefully for injury (Gannon & Sikes, 2007).

With most traps, different attractants are used to lure the animals into the traps and these may either be olfactory, visual or audible in nature (Brand, 1993). Olfactory attractants are used most often and may include natural lures (substances that occur naturally in the environment and may lure the animal), territorial lures (territorial odours in faeces and urine) and food baits. The latter is often not recommended as they may attract non-target species (Brand, 1993). Kock & Burroughs (2012) reported that wild felids in North and South America as well as big African cats such as leopards cannot resist the smell of Calvin Klein

Obsession for Men so that it has been, rather successfully, used to lure big cats into camera traps.

Drop-nets

Net capture is a relatively old but popular technique which is less expensive in comparison to the boma capture technique (Broekman, 2012). The drop-net capturing method became available in 1966 and in South Africa, drop-nets can be used for small and medium sized antelope species as well as warthog (*Phacochoerus africanus*) and wild dog (*Lycaon pictus*) (Wildlife Materials Inc., 2005; Denicola & Swihart, 2012) . The system has been shown to be extremely successful in the capture of smaller species inhabiting dense bush, such as bushbuck (*Tragelaphus scriptus*) and nyala as well as animals inhabiting open plains like blesbok, springbok, oribi (*Ourebia ourebi*), impala and tsessebe (*Damaliscus lunatus*) (Broekman, 2012).

The system generally consists of a mesh nylon net erected in the field and camouflaged by both its colour and the natural vegetation. The nets are suspended by cables, metal or wooden poles (in grassland areas – Fig. 1) or vegetation (in bushveld areas) so that when animals are herded (usually by vehicle, on horseback, on foot or by helicopter) into the nets, the attachments collapse and the nets fall down so that the animals become entangled in them (Openshaw, 1993a; Bothma, 2002; La Grange, 2006; Broekman, 2012; Lekolool, 2012). A cable can also be used that is released by an observer so that the nets are dropped manually when animals enter the demarcated area (Kock & Burroughs, 2012). The height of the nets will be determined by the species but 2 metres is usually sufficient for larger species (Bothma, 2002). The bottom part of the net (usually about 1 metre) lies flat on the ground so that animals cannot lift the nets with their horns and escape (Bothma, 2002). Once entangled in the net, animals are usually handled and tranquillized by assistants and it is recommended that at least 3–5 people are present (usually more in larger set-ups) to handle animals after the capture (Wildlife Materials Inc., 2005; Broekman, 2012). For illustrations of different drop-net systems used on African herbivore species, refer to Knox, Zeller and Hattingh (1992), Bothma (2002), La Grange (2006) and Broekman (2012).

The use of nets is advantageous in areas where there is not enough vegetation to camouflage plastic bomas (Bothma, 2002; SANParks, 2013). In addition, the nets are easy to erect, can be used repeatedly and have durability but they are labour-intensive. Being so labour-intensive with regards to handling and costly in terms of helicopter time, a large number of animals are usually caught in nets in order to make it economically viable (Bothma, 2002; Broekman, 2012). It must also be borne in mind that this system is a very rough and traumatic method of capture and that numerous studies have found it to cause elevated

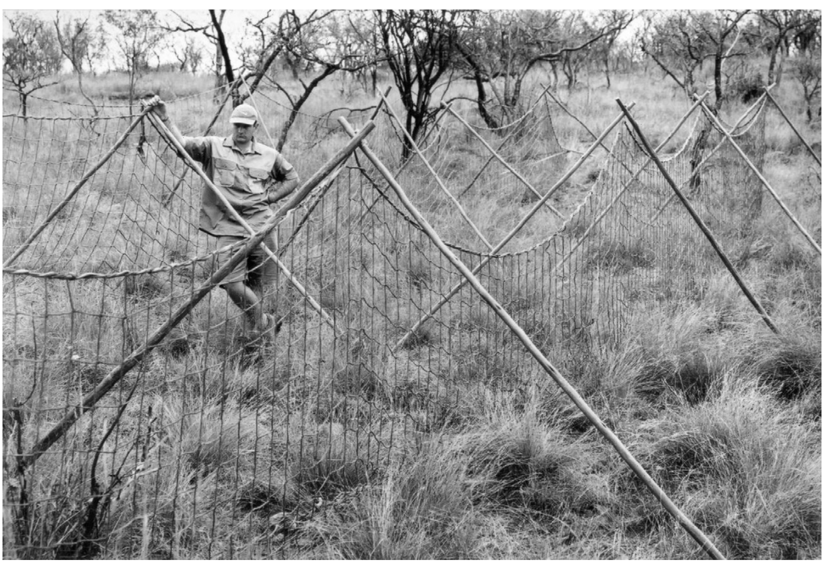

Fig. 1. A drop-net set up in the field using wooden poles. (Photograph courtesy of J.P. Raath.)

stress responses and increased body temperatures due to the chasing of the animals (Knox *et al.*, 1992; Openshaw, 1993a; Ganhao, Hattingh & Pitts, 1988; Broekman, 2012; Denicola & Swihart, 2012). The use of nets also involves increased handling of the animals, may result in injuries or suffocation due to strangulation in the net and increases the time taken to load animals (SANParks, 2013).

Net guns

A net gun is a hand-held physical restraint device that uses an explosive charge to project a net over an animal and was originally developed in New Zealand to capture deer (*Cervus* spp.) in mountainous areas (Morkel & La Grange, 1993). Square or triangular nylon nets are loaded into a special canister which is then loaded into a 3 or 4 barrel firearm and fired with a blank cartridge (Bothma, 2002). The animal becomes entangled in the net and is then handled, blindfolded and tranquillized by assistants, in the same way as normal net capture (Bothma, 2002; Broekman, 2012).

Net guns, fired either from a vehicle or a helicopter, can be used for smaller plains game species such as reedbuck (*Redunca* spp.) and sitatunga (*Tragelaphus spekii*) that do not herd well in groups as well as mini antelope species such as duiker (*Sylvicapra grimmia*), dik-dik (*Madoqua* spp.) and klipspringer (*Oreotragus oreotragus*) (Morkel & La Grange, 1993; Kock & Burroughs, 2012). Larger species can be captured with a net gun but manual restraint may be difficult once the animal is in the net, particularly with adult males. Adult male eland, roan antelope (*Hippotragus equinus*) and zebra (*Equus burchellii*) are sometimes restrained with a net gun after having been darted and this technique holds advantages in that helicopter time can be reduced and overexertion can be avoided (Morkel & La Grange, 1993). Net guns are suitable to capture animals in large reserves or farms with scarce vegetation (Broekman, 2012). In areas with trees, a triangular net is commonly used because it has a longer range (Bothma, 2002).

The system is sometimes advantageous over chemical immobilization methods in that it is cheaper to operate and the area where the animal is captured can be selected (*i.e.* the animal can be herded to a suitable area before the net gun is used and then cannot run into a less suitable area) (Morkel & La Grange, 1993). Although this system is a cheaper alternative to chemical immobilization, the same risks, namely injury and an increased stress response, is associated with this system as with drop-nets and the system requires a high degree of skill and co-ordination between the operator and the driver/pilot (Morkel & La Grange, 1993; Kock & Burroughs, 2012). A highly experienced pilot is required with good communication between the pilot and the operator. During pursuit and particularly during the final phase before the gun is fired, the helicopter can fly as low as 5 m from the ground. The pilot has to concentrate on the fleeing animals while still being continually aware of physical obstacles, wind patterns, lift capability and other factors that may result during pursuit (Barrett, Nolan & Roy, 1982; La Grange, 2006).

Mass capture bomas

For the mass capture of species, net or plastic bomas are generally used so that animals are driven into the bomas using a helicopter (Young, 1984; Bothma, 2002). This method was developed in South Africa by Jan Oelofse in 1968 after he had witnessed numerous capture operations in the Umfolozi and Hluhluwe reserves on horseback with nooses and nets result in high rates of injuries and mortalities (Oelofse, 2010). This technique revolutionized game capture in South Africa and enabled capture teams to capture large numbers of animals in a relatively short amount of time (Dugmore, 2013). Today, this is the most widely used method of mass capture in South Africa and is suitable for use with most species, including impala, zebra, kudu (*Tragelaphus strepsiceros*), buffalo, giraffe (*Giraffa camelopardalis*) and even wild dogs.

Plastic sheeting or netting (in areas with limited natural camouflage) is used to construct a boma in the shape of a large funnel (Kock & Burroughs, 2012). The entrance should ideally be 100–120 metres wide and well camouflaged to allow adequate space for the animals to enter (Openshaw, 1993a). The funnel consists of different segments separated by plastic curtains which allows for the animals to be herded (since the animals view the sheeting as a solid wall and when attempting to escape, run further up the funnel) towards a ramp situated at the end of the funnel and leading into a transport truck (Figs 2 & 3) (La Grange, 2006; Kock & Burroughs, 2012; Lekolool, 2012). Once animals enter the boma, the curtains are systematically closed behind them by manual operators

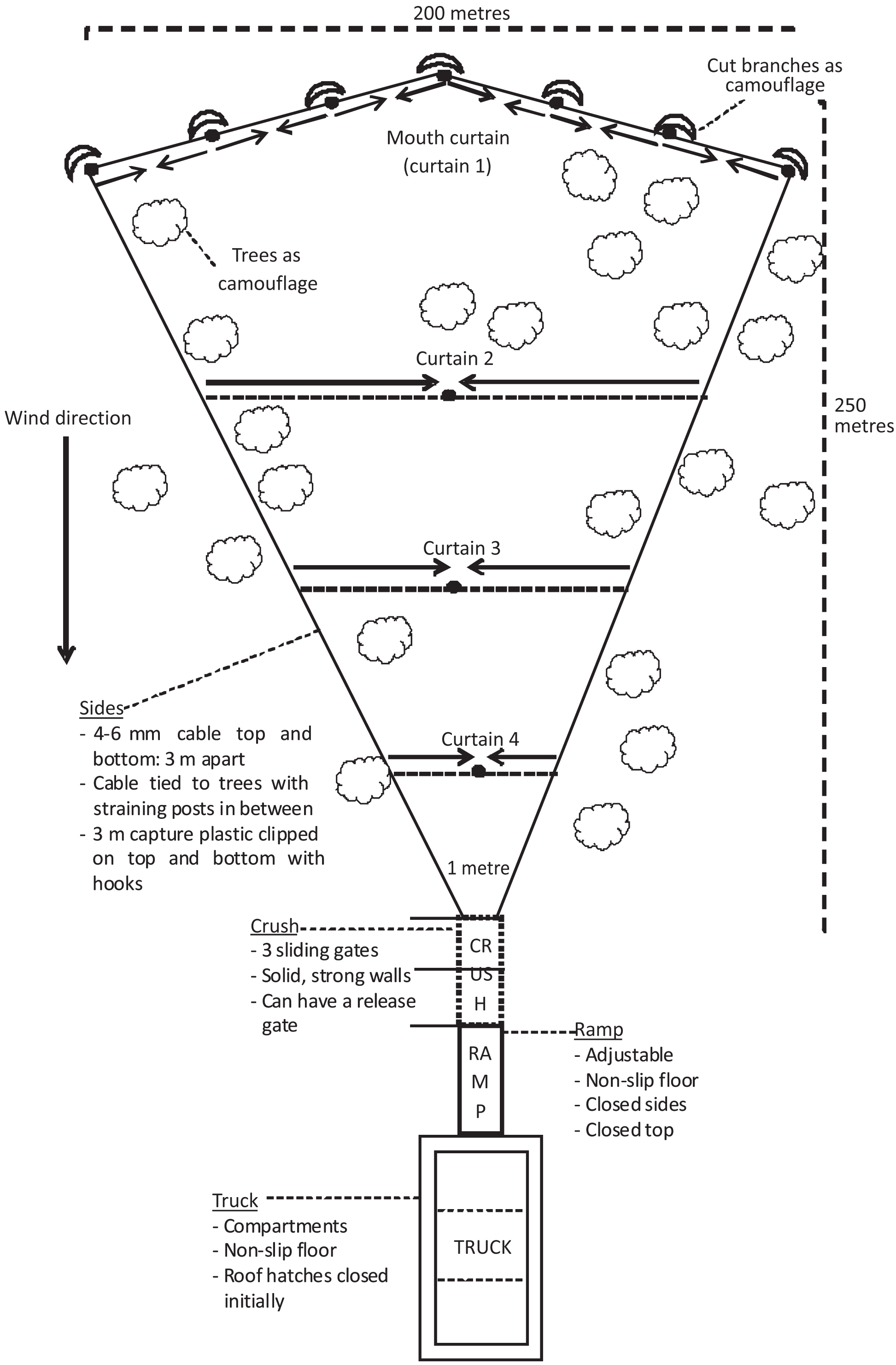

Fig. 2. Diagrammatic representation of a mass capture boma. The animals are moved through the funnel toward the crush and each curtain is closed once the animals have passed it. Animals are moved through the crush onto a ramp and into a transport truck.

Fig. 3. A plastic boma set up in the field for the mass capture of impala, which shows the funnel with curtains as well as the crush and ramp leading up to the transport truck. (Photograph courtesy of L.L. Laubscher.)

so that animals move forward into the boma (Bothma, 2002).

During the construction of the boma, the area in front of the entrance must be left undisturbed (free of human activity and vehicle movement) and the loading ramp and crush must be on ground level if possible, to prevent injury (Openshaw, 1993a). The funnel entrance must face into the wind and animals must be herded slowly until they are close to the funnel entrance and then chased quickly through the funnel/boma (Bengis, 1996). Other important factors that will affect the success of the system include the capability and experience of the helicopter pilot, the strength and direction of the wind, adequate camouflaging of the boma walls, the co-operation of the ground team and communication between the pilot and the ground team (Bothma, 2002; La Grange, 2006).

This system has the advantage that highly stress-susceptible species such as kudu can be successfully captured and transported with minimal trauma and no handling and without the necessity for immobilizing drugs (SANParks, 2012; Kock & Burroughs, 2013). In addition, human–animal contact is minimized and a large number of animals (even entire herds) can be captured and transported as a single entity (Lekolool, 2012). Since the equipment required can be expensive and vehicles and containers need to be of a high quality, this system is only financially viable if large numbers of animals are to be captured (SANParks, 2013). In addition, the high costs involved in using a helicopter means that enough animals need to be captured successfully in order to keep the costs per animal as low as possible. Other disadvantages are that the system is very time and labour-intensive as well as being wind and weather dependent.

Passive capture sites

Using the same techniques as described above without the herding of animals, passive capture sites are also used to capture large groups of animals. These may consist of drop-nets or net- or plastic bomas that are constructed at watering holes or feeding grounds, and left there until enough animals have entered the passive capture site. Often, attractants such as feed or water are used to lure animals inside and habituate them to the passive capture site. Once enough animals are inside, the boma walls are closed or the drop-nets released and the animals then captured or chased into transport units (Openshaw, 1993a; Kock & Burroughs, 2012). This method is suitable for most of the species described above and is especially useful when there are no time constraints. It is also much less stressful than other methods which involve chasing the animals (SANParks, 2013). Presently, to minimize the stress caused by human–wildlife interactions, cameras are also set up in the boma and when the target animal/group has entered, the closing of the walls/gate or dropping of the net is triggered remotely. A disadvantage of this system is that non-target species may also be lured into the capture site and will then need to be removed prior to the loading of animals.

THE TRANSPORTATION OF LIVE GAME

During the transportation of game, the most important aspect to take into consideration is the welfare of the animals. As such, suitable equipment and practices should be employed as pertaining to the specific species being transported. Criteria that should be kept in mind when planning a transportation operation include the species characteristics (*e.g.* naturally aggressive species should be transported in individual crates and under tranquillization), the life history and population dynamics of the species (*e.g.* some herbivore species require boma training before being transported), route (*e.g.* whether animals are being transported by road, air or sea) and costs (Openshaw, 1993b). The South African Bureau of Standards as well as the Animal Protection Act No 71 of 1962 provides guidelines to game capturers and wildlife owners pertaining to equipment and appropriate procedures for the transportation of wildlife and it is in the interest of all parties concerned to stringently follow these guidelines as to minimize potential losses (South African National Department of Agriculture and National Directorate of Animal Health, 1962; South African Bureau of Standards, 2007). Such losses may include injuries due to inadequate transport equipment being used or overloading of animals as well as potential death, resulting in substantial financial losses. Capture myopathy has been found to occur within hours and up to 14 days after transportation with resulting mortalities up to four weeks post-capture and transportation (Harthoorn & Van der Walt, 1974; Broekman, 2012).

The first aspect to take into considering is the loading of the animals and according to Kock and Burroughs (2012), the following guidelines should be adhered to when loading the animals to be transported:

1. The operation should never be rushed.
2. Animals should be allowed to rest before loading when they appear exhausted and hot. It must be noted that this may be problematic in species such a zebra where loading soon after capture is essential to avoid aggression between animals.
3. Tranquillization should be considered for apparently stressed or potentially aggressive animals.
4. Mature males should be removed prior to loading to avoid fighting during transportation.
5. Excessive movement and noise by staff and capturers should be avoided in order to calm stressed animals down.
6. Animals should be counted and loaded in groups according to space requirements.
7. Animals should be partitioned appropriately, with adequate space and ventilation.
8. If animals are not calmed and settled properly, they should be unloaded and reloaded again.

Crate design for the transportation of wildlife is of utmost importance. Animals can either be transported individually in single crates or in groups in mass crates (Bothma, 2002). The type of crate used will depend entirely on the species with naturally aggressive species that have the potential to injure their counterparts, having to be crated individually. Such species include tsessebe, reedbuck and small antelope such as suni (*Neotragus moschatus*) and duiker. Alternatively, animals can be tranquillized and their horns fitted with piping to protect the animals during fighting. Commonly, bulls are removed from most groups of animals when transported except for species such as gemsbok (*Oryx gazella*) and blue wildebeest which can be transported safely in mixed-sex groups. Some species have unique transport requirements, for example, nyala calm down very quickly when branches and leaves are hung down in the boma and transport truck/crate. Openshaw (1993b) and Bothma (2002) provide guidelines for the transportation of each specific species. Stringent guidelines should also be followed when considering crate designs so as to minimize animal stress and possible injury and to ensure proper ventilation during hot days and or heat retention during trips in cold conditions. General principles that apply to crate design include (Openshaw, 1993b; Bothma, 2002; Kock & Burroughs, 2012):

1. The size and strength of the crate should be appropriate to accommodate and restrict the animal while still allowing the animal to stand or lie down as necessary.
2. Ample ventilation is a strong pre-requisite but gaps at eye-level should be eliminated so that animals cannot sense movement outside.
3. The floor should allow for drainage of urine and water whilst still provide a surface that is safe and secure for the animal to retain its footing.

4. All doors, including partition doors between communal crates should move freely and without hindrance (and a minimum of noise) and should be a minimum of 1 m wide to allow animals to pass through without feeling threatened.
5. The tops of the crates should be accessible so that animals can be reached if necessary (*e.g.* for the administration of tranquillizers) without the animals being able to escape.

Transport vehicles should also adhere to specific designs and criteria and for both crates and vehicles, The Wildlife Translocation Association provides Certificates of Adequate Equipment to certify that their members' capture equipment meets certain standards. These permits are recognized by the South African Government in relation to the issuing of transport permits (Higginbottom & King, 2006).

The use of both short- and long term tranquillizers during the transportation of wildlife is common practice and these are used extensively on aggressive animals in mass crates and even in single crates (Openshaw, 1993b).

HOLDING/BOMA FACILITIES

Extensive guidelines are available for the appropriate set-up of holding/boma facilities. Some reasons for the keeping of wildlife under captive conditions include the holding of animals at game auctions, the collection and keeping of animals prior to translocation, the adaptation of animals prior to release, quarantine of animals, research, and the treatment of sick, injured or malnourished animals (Bothma, 2002). Prior to the construction of holding facilities, the location of the facility should be taken into account so that weather conditions throughout the year, the availability of water and human disturbances (*e.g.* excessive traffic and noise that may stress animals) should be considered (Kock & Burroughs, 2012). When constructing such facilities, basic animal needs need to be addressed such as the adequate provision of shade and protection against rain, constructing the facilities on a slope to allow for drainage, sufficient ventilation, appropriate feed containers and water troughs that cannot be moved around by animals or cause injury (elevated hay racks will be needed for species like giraffe although most animals feed at or near ground level) and size that allows for enough movement (it is recommended that 1 m^2/50 kg body weight is provided) (Ebedes, 1993; Bothma, 2002). Depending on the species, other specifications will also have to be kept in mind so that, for example, the holding pens for giraffe will differ significantly from those for rhino. The behaviour of a specific species will also determine whether groups can be kept together or whether dominant individuals must be kept separately so that such factors will determine the size of the holding pen (Bothma, 2002). Species such as kudu can jump over walls that are 2.4 m and lower so that this should be taken into consideration (Kock & Burroughs, 2012). The holding pens and gates should also be designed to facilitate ease of movement and minimize stress of the animals and no sharp or protruding structures should be found in or around the facilities as these may cause injury to the animals during movement (Kock & Burroughs, 2012). Holding pen walls are usually constructed from sturdy gum-poles and, depending on the construction methods, these walls can be lined internally or externally with sheeting (typically old used rubber conveyor belts) so that newly introduced animals cannot see outside (Kock & Burroughs, 2012).

GENERAL TRANSLOCATION GUIDELINES

Although all the methods described above have been successfully used in game capture operations across South Africa, Kock & Burroughs (2012) noted the following factors that are important to consider to guarantee the success of the capture operation:

1. Condition of the animal: poor body condition or pregnancy can increase the animal's stress-susceptibility.
2. Age: older or very young animals may be more stress-susceptible.
3. Ambient temperatures: capture of wild animals should be carried out during winter or the cooler hours of the day to prevent the animals from over-heating.
4. Physical terrain: animals may be reluctant to enter thick bush or cross a fence.
5. Boma siting: bomas should be located as close as possible to the animals being captured to prevent over-exertion during the chase.
6. Time of capture: this will be dependent on ambient temperatures.
7. Human contact: increased human contact can lead to unnecessary stress.
8. Equipment: equipment should be carefully maintained and well-designed and manufactured.
9. Disturbance: minimal human disturbances

prior to capture can help minimize the stress-susceptibility of the animals.

10. Provision of food and water: if the animals are to be transported over a long period of time, sufficient food and water should be supplied.
11. Mixing species: species should never be mixed when transported.
12. Crowding: over-crowding should be prevented to prevent injuries and stress to the animals.
13. Transport containers: containers or crates should be well-constructed and strong enough to prevent animals from breaking through them.
14. Off-loading: planning and correct crate design can prevent any problems when off-loading animals. A temporary off-loading boma should be considered especially when gregarious animals are off-loaded in large areas.
15. Time of year: the calving season of a species will determine when certain species can be captured since pregnant animals or very young animals are not suitable for translocation.

CONCLUSIONS AND WELFARE IMPLICATIONS

The South African wildlife industry is a fast-growing industry with large numbers of animals being translocated annually. Bezuidenhout (2014) reported that wildlife auctions during 2013 reached a record high turnover of R1.029 billion with 23 963 animals being sold at 67 official South African wildlife auctions. However, the number of annually translocated animals, country-wide is likely much higher. According to Ebedes, Van Rooyen & Du Toit (2006) more translocated animals died of capture myopathy in the last 30 years in southern Africa than from any other wildlife diseases (Broekman, 2012). This disease has been shown to be strongly related to stress and as a result, there is a need for the understanding, selection and execution of appropriate capture and translocation methods. Such methods have evolved considerably since the 1970s, with significant advances being made to minimize animal handling and stress (Oelofse, 2010; Dugmore, 2013). Such advances include the use of techniques that do not involve chasing animals into traps or snares as well as the use of passive capture methods when time and environmental conditions allow. In addition, the use of chemical immobilization and sedation together with physical restraint has greatly improved capture and relocation outcomes, with increasing research being conducted on the use of such combinations (Fahlman, 2008). Overall, successful capture and relocation of wildlife is greatly dependent on operator experience and knowledge as well as effective decision making during the planning of a capture operation (Kock & Burroughs, 2012).

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