Cheetah Translocation and Reintroduction Programs: Past, Present, and Future

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CHAPTER

20

Cheetah Translocation and Reintroduction Programs: Past, Present, and Future

*Lorraine K. Boast**, *Elena V. Chelysheva***, *Vincent van der Merwe*[†], *Anne Schmidt-Küntzel*[‡], *Eli H. Walker*[‡], *Deon Cilliers*[§], *Markus Gusset*[¶], *Laurie Marker*[‡]

***Cheetah Conservation Botswana, Gaborone, Botswana**
****Mara-Meru Cheetah Project, Kenya Wildlife Service, Nairobi, Kenya**
[†]Endangered Wildlife Trust, Modderfontein, Gauteng, South Africa
[‡]Cheetah Conservation Fund, Otjiwarongo, Namibia
[§]Cheetah Outreach Trust, Cape Town, South Africa
[¶]World Association of Zoos and Aquariums, Gland, Switzerland

INTRODUCTION

The deliberate movement of individuals of species from one site for release to another (i.e., translocation) is a conservation tool used with increasing frequency (Seddon et al., 2007). "Conservation translocations," as opposed to those conducted purely for commercial objectives or to reduce human-wildlife conflict, have the purpose to yield a "measurable conservation benefit at the levels of a population, species, or ecosystem" (IUCN SSC, 2013). In other words, the benefit should go beyond the translocated individual. Conservation translocations are conducted to maintain gene flow, for example, during metapopulation management, or as part of a reinforcement or reintroduction program, to restore animals to an area where they are threatened or no longer occur. Due to their prey requirements and potential for human-wildlife conflict, carnivores, especially large species, are considered harder to translocate than herbivores

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(Wolf et al., 1996). However, there have been successful carnivore reintroduction programs, for example, gray wolves (*Canis lupus*), Eurasian lynx (*Lynx lynx*), and brown bears (*Ursus arctos*) (Hayward and Somers, 2009).

As cheetah (*Acinonyx jubatus*) populations continue to decline in numbers and range (Durant et al., 2017), the reintroduction of cheetahs into suitable areas of habitat has been suggested as a potential conservation measure. Cheetahs display characteristics necessary for successful translocation; for example, they can tolerate a wide variety of areas and consume a broad range of prey species (Caro, 1994). However, they naturally occur at low densities, have large home ranges, are susceptible to competition from larger carnivores, and their release may be viewed negatively by land users within or near release sites (Chapters 8, 9, and 13). This chapter provides an overview of the knowledge and past experience of cheetah translocations, in order to discuss the feasibility of reintroduction programs as a conservation measure for the species.

RATIONALE FOR THE TRANSLOCATION OF CHEETAHS

Reintroduction programs have the potential to increase the current distribution of cheetahs by reclaiming past distribution areas. Additionally, releasing cheetahs into small existing cheetah populations or reestablishing connectivity between fragmented cheetah populations has the potential to boost genetic diversity at a local scale (Johnson et al., 2010b), thereby minimizing the genetic and demographic problems associated with small populations (Chapter 6 and 10). As cheetahs disperse over long distances (Marker, 2002), recolonization of large areas and enhancement of gene flow between relatively distant populations might be achieved through the reintroduction of connector populations.

The reintroduction of cheetahs also has the potential to benefit other species. Large carnivores have cascading effects on lower trophic levels and are necessary for the maintenance of biodiversity and ecosystem functioning. For example, the recovery of Eurasian lynx and gray wolf populations has arguably restored ecological balance to areas where populations of these top predators had diminished (Ripple et al., 2014). The cheetah could also act as a flagship species for the reintroduction site, acting as an ambassador for its protection. Proponents of cheetah reintroductions also argue that, as humans, we have an ethical responsibility to reintroduce cheetahs, as it was human expansion that was responsible for their removal (Ranjitsinh and Jhala, 2010).

PAST CHEETAH TRANSLOCATIONS AND METAPOPULATION MANAGEMENT

The first translocated cheetahs were released into fenced and unfenced nationally protected areas during the 1960s and 1970s in Namibia and South Africa, to reintroduce or reinforce existing populations (Anderson, 1983; Du Preez, 1970). Subsequent cheetah releases into unfenced environments have been documented (Boast et al., 2016; Marker et al., 2008; Purchase and Vhurumuku, 2005; Weise et al., 2015). However, the vast majority of translocated cheetahs were released into fenced areas. Legislation passed in South Africa in the 1960s returned the right to utilize wildlife to landowners, paving the way for the development of private game reserves (McGranahan, 2008). In 1991, landowners began stocking private reserves with cheetahs for tourism purposes, and cheetah translocations intensified during the mid-1990s to mid-2000s (Chelysheva, 2011). These reserves are fenced with "predator-proof," often electrified fencing. Although no fence will retain all predators with 100% effectiveness, "predator-proof" fencing reduces the chance that predators will be able to leave the reserve. The number of cheetahs released in each reserve is usually small [2–8 cheetah in 74% of sites (n = 65) reviewed by Chelysheva (2011)]. In 2009, the decision was taken to manage the cheetahs in South African private game reserves as a metapopulation, with the aim of maintaining demographic and genetic viability (Lindsey and Davies-Mostert, 2009; see http://www.cheetahpopulation.org.za for further information). By 2016, cheetah reintroductions had been attempted at 72 fenced reserves in South Africa, and the metapopulation has increased naturally from 241 cheetahs in 41 reserves in 2011 to 325 individuals in 54 reserves (16 state owned and 38 private game reserves) in 2017 [Endangered Wildlife Trust (EWT), unpublished data]. The metapopulation program has the potential to support a viable population of cheetahs, but it is not sustainable without intensive management (Lindsey et al., 2009a).

SUCCESS OF PAST CHEETAH TRANSLOCATIONS

Evaluating the success of cheetah translocations is complicated. The outcomes of many incidences are unpublished and those that are published potentially suffer from positive publication bias (i.e., successes are more likely to be published than failures). Success is generally based on reproductive success, but programs often use different definitions of this term (Hayward et al., 2007a). A metaanalysis of documented cheetah translocations determined that at least 727 cheetahs were translocated into 64 sites in southern Africa between 1965 and 2010 (Chelysheva, 2011). Six of the 64 release sites were considered successful (Chelysheva, 2011) based on natural recruitment (i.e., births) exceeding adult mortality 3 years after reintroductions began (as defined in Hayward et al., 2007a). In many of the other projects, the number of cheetahs released was small and long-term monitoring was not conducted. If such long-term monitoring had been implemented and documented, additional sites might have been deemed successful. Indeed, as of 2016, 71% of the 72 sites at which cheetah reintroductions have been attempted in South Africa have breeding populations of cheetahs, which are currently contributing to the South African metapopulation (EWT, unpublished data).

Four of the six sites, deemed successful by Chelysheva (2011), have persisting cheetah populations in 2016 (EWT, unpublished data). Three of these four sites are fenced reserves within the South African metapopulation and one is a free-ranging population in Zimbabwe's Matusadona National Park. However, after an initial population growth (Purchase and Vhurumuku, 2005) this free-ranging population has declined to three related individuals (van der Meer, 2016). Insufficient area of habitat (due to rising lake levels), increasing human-wildlife conflict on park borders (in response to a growing human population and an economic crisis in Zimbabwe), a lack of subsequent cheetah releases, and limited opportunity for natural colonization are likely to have contributed to its failure (van der Meer, 2016). It is considered inadvisable to conduct future translocations into the area and unfeasible to incorporate the population into a metapopulation plan (van der Meer, personal communication). Without this support, this free-ranging population is not viable in the long term (van der Meer, 2016).

However, since the Chelysheva (2011) metaanalysis, the successful translocation of rehabilitated orphaned cheetahs and cheetahs suspected of killing livestock into the unfenced NamibRand Nature Reserve in Namibia has been documented (Marker, et al., in preparation; Weise et al., 2015). Cheetahs were previously believed to be absent or transient in the reserve, and these releases have resulted in the establishment of a self-sustaining resident cheetah population in the larger pro-Namib ecosystem (Weise and Odendaal, personal communication).

POSTRELEASE MOVEMENTS OF CHEETAHS

The most critical period for the survival of translocated cheetahs is the first 3–4 months postrelease (Fontúrbel and Simonetti, 2011; Hunter, 1999; Weise et al., 2015). During this initial period, carnivores often make large exploratory and sometimes directional movements, often toward home (Linnell et al., 1997; Marker et al., 2008). For example, 5 out of 20 translocated cheetahs studied in Namibia roamed over 2000 km^2 during the first 3 months after release (Weise et al., 2015), and an individual in Botswana returned to its capture site after being translocated 170 km away (Boast et al., 2016).

Cheetahs tend to stop exploratory and directional movements within 2–3 months postrelease (Hunter, 1999); after 3 months, cheetahs translocated in Namibia showed no significant difference in home range sizes and daily movements compared with cheetahs released at the capture site (Marker et al., 2008). During this critical period in free-ranging environments, the large movements expose cheetahs to multiple threats, including crossing roads and farmland owned by multiple landowners, some of whom are likely to be intolerant of predators. As a result, high mortality rates of cheetahs released into free-ranging environments are often (although not always; Marker et al., 2008) recorded during this initial period (Boast et al., 2016; Weise et al., 2015) (Table 20.1). Human-mediated mortality is the primary cause of death for cheetahs translocated into free-ranging environments (Boast et al., 2016; Du Preez, 1970; Purchase and Vhurumuku, 2005; Weise et al., 2015).

TABLE 20.1 Survival Rates of Documented Cheetah Translocations

		Percentage of adult animals surviving[a]		
Release site[b]	**Source of cheetahs**[c]	**110 Days postrelease**	**1 Year postrelease**	**Source**
Various *fenced reserves* in South Africa	Suspected damage causing	Not stated	85% (n = 92)	Marnewick et al. (2009)
Fenced reserve in Namibia	Orphaned	100% (n = 10)	60% (n = 10)	Marker et al. (in preparation)
Free-ranging reserve in Namibia	Orphaned	71% (n = 7)	71% (n = 7)	Marker et al. (in preparation)
Various *free-ranging* sites in Namibia	Suspected damage causing Orphaned	71% (n = 17) 40% (n = 5)	56% (n = 16)[d] 25% (n = 4)[d]	Weise et al. (2015)
Various *free-ranging* sites in Botswana	Suspected damage causing	33% (n = 11)	18% (n = 11)	Boast et al. (2016)
Free-ranging reserve in Botswana	Orphaned	100% (n = 3)	0% (n = 3)	Houser et al. (2011)

[a]*110 days and 1 year postrelease survival were success rate criteria used by Fontúrbel and Simonetti (2011).*
[b]*Fenced refers to predator-proof fencing.*
[c]*Suspected damage-causing cheetahs are those perceived by landowners to be depredating on livestock, although evidence of depredation was not always present.*
[d]*Collar failed for 1 cheetah.*

FACTORS ASSOCIATED WITH THE SUCCESSFUL TRANSLOCATION OF CHEETAHS

The principal factor associated with reproductive success in a carnivore translocation program is the suitability of the release site for the target species, and in the case of free-range releases, the suitability of the surrounding area. Important characteristics of the release site include habitat and prey availability, the potential for intra- and interspecific competition, and the cheetahs' ability to leave the site (Johnson et al., 2010a). Additional factors known to affect success are the individual cheetah's background, number, and grouping of cheetahs released, the method of release, and the availability of postrelease monitoring and care. The success of a reintroduction program will also require the support of people living near the release site. Reintroduced animals must not threaten resident wildlife, for example, through disease, genetic factors or competition, and the program must be cost effective. These factors will be discussed to offer insight into the feasibility of reintroduction as a conservation measure for cheetahs and to guide future programs.

Free-Range Versus Fenced Release Sites

In some areas, fenced release sites may be the only option available, for example, in densely populated and more developed regions of South Africa, Malawi, and Swaziland. Animals reintroduced into reserves with "predator-proof" fencing experience greater reproductive success than animals reintroduced into unfenced free-ranging environments (Chelysheva, 2011). Five of the six reintroduction sites considered as successful in Chelysheva's (2011) metaanalysis of cheetah translocations were reserves with "predator-proof" fencing (Bissett, 2004; Hayward et al., 2007a; Hofmeyr and van Dyk, 1998; Hunter, 1998a; Pettifer et al., 1982). In areas with "predator-proof" fencing, it is difficult for cheetahs to leave the reserve; they are protected from external causes of mortality (e.g., human–predator conflict), and also generally receive greater follow-up and care than is possible for cheetahs released into free-ranging areas. However, despite cheetahs having a greater chance of survival in fenced environments (Table 20.1), these populations must be intensely managed to maintain genetic diversity and avoid exceeding the reserve's carrying capacity of carnivores. Not all cheetahs in fenced reserves are part of a metapopulation management plan, and even those that are included, are dependent on intensive management and are potentially vulnerable to changes in land ownership, land-use, and financial support. As a result, metapopulation management may not be the most appropriate long-term option across the cheetah's range. Where possible, reintroduction programs for cheetahs should focus on free-ranging areas, where cheetah dispersal could potentially facilitate natural colonization and connectivity with existing populations.

Characteristics of Release Sites: Ecological Factors

It is imperative that the threats responsible for the initial removal of cheetahs at potential release sites are addressed, or plans are in place to mitigate the threat (Hayward and Slotow, 2016). A habitat suitability study should be conducted at each site to ensure there is sufficient vegetation to support viable prey populations to sustain the reintroduced cheetah population in the long term. In fenced reserves sufficient prey should be available to sustain the reintroduced cheetahs and all other predators for at least 18 months before supplementation. The reintroduced cheetah population needs to be protected from anthropogenic threats, and the potential impact of unnaturally high inter- and intraspecific competition needs to be managed.

Due to the cheetah's large home ranges and tendency to occur at low densities (Chapter 8), release sites need to be part of a larger suitable landscape or else intensive metapopulation management becomes necessary. Using habitat modeling, Weise et al. (2015) found that the released cheetahs' movements would extend beyond the boundary of all protected areas in Namibia, regardless of the chosen release site. Nevertheless, cheetahs can survive in unprotected landscapes (e.g., 77% of the cheetah's current known range is on unprotected land: Durant et al., 2017). However, safeguarding areas of suitable habitat around the release site and providing wildlife corridors for natural cheetah dispersal and connectivity between populations will be necessary.

One of the key factors in determining reintroduction success in the metaanalysis of cheetah translocations by Chelysheva (2011) was the density of lions (*Panthera leo*) and spotted hyenas (*Crocuta crocuta*) in the release area. In addition to interspecific competition, intraspecific competition is also likely to have an impact on the survival of cheetahs released to reinforce existing populations. The presence of resident cheetahs can result in territorial fights, sometimes leading to the death of reintroduced individuals (Bissett, 2004; Hayward et al., 2007a; Marker et al., 2008). At the very least, competition is likely to result in reintroduced cheetahs needing to roam further to establish themselves in the area (Pettifer et al., 1982), potentially increasing their exposure to threats.

Source of Cheetahs for Reintroductions

Cheetah reintroductions are most likely to succeed if founder animals are healthy adults, sourced from similar environments (e.g., prey density, competitors) to those into which they will be released. If animals will be released in areas with other large carnivores, it is recommended that reintroduced cheetahs have experience with these competitors (Boast et al., 2016; Hayward et al., 2007b; Hunter, 1998a; Weise et al., 2015). A reintroduced cheetah's naivety of large competitors is thought to contribute not only to the poorer survival of the individual but also poorer survival of cubs born to naive mothers (Marnewick et al., 2009). Ideally, cheetahs should be sourced from an area with these large predators (Hayward et al., 2007b); although exposure during soft release (when cheetahs are temporarily held in a holding-pen at the release site) is also thought to improve survival outcomes. For releases into fenced reserves, within a metapopulation management plan, the best source of cheetahs are those from within a viable existing metapopulation. For example, 5–10 cheetahs become available for reintroduction attempts per year from the South African metapopulation (EWT, unpublished data). These cheetahs are successful hunters and in the majority of cases have experience of large competitors (e.g., 73% of reserves in the South African metapopulation have lions). However, predominately, these cheetahs are highly habituated to the presence of game-drive vehicles, and habituated cheetahs make poor candidates for release into free-ranging environments where they are likely to encounter human presence.

For release into free-ranging environments, there is no ideal source of cheetahs. The removal of cheetahs from the wild, even from within healthy populations, should not be advocated due to the potential strain it could place on source populations. Past reintroduction programs have used cheetahs perceived by landowners to be predating on livestock (Marnewick et al., 2009; Purchase and Vhurumuku, 2005). These suspected damage-causing cheetahs are often threatened with lethal control if not removed (see Box 20.1 for a discussion on translocating cheetahs to reduce human-wildlife conflict). Although the risk of transferring conflict is thought to be low (Purchase and Vhurumuku, 2005) and these cheetahs are likely to have a fair chance of survival because they have experience of the wild; the primary message promoted by cheetah conservationists on farmland should be coexistence not removal.

BOX 20.1

TRANSLOCATING CHEETAHS TO REDUCE HUMAN-CHEETAH CONFLICT

Conservation organizations are often under pressure to translocate cheetahs that are believed to be responsible for livestock depredation to prevent them from being killed, and as such, translocation is often considered a humane method to mitigate human–carnivore conflict (Massei et al., 2010). Frequently; however, the demand for cheetah removal outweighs the availability of suitable reintroduction sites and resources. As a result, the majority of cheetahs captured due to perceived or actual depredation on livestock have been relocated within existing cheetah populations, without clear reintroduction aims. These translocations, although potentially promoting gene flow and survival of individuals, cannot be viewed as "conservation translocations" (IUCN SSC, 2013), as their benefit is largely restricted to individuals rather than populations.

In a bid to better utilize perceived conflict cheetahs, and as a trial conflict mitigation method, a compensation–relocation program was carried out in South Africa between 2000 and 2006. Cheetahs perceived to be predating on livestock were captured by landowners and relocated to private reserves and national parks (Lindsey et al., 2009a; Marnewick et al., 2009). The cheetahs captured and removed both in South Africa and as part of other translocation programs were generally perceived, but not known, to have killed livestock. As a result, although there is a chance some cheetahs will kill livestock at the release site (Boast et al., 2016), cheetah conflict with human populations neighboring free-ranging release sites does not necessarily increase (Purchase and Vhurumuku, 2005).

The translocation of those predators, suspected to be killing livestock, provides farmers with a perceived level of control over predation risk, as cheetahs can be removed if their presence can no longer be tolerated (Marnewick et al., 2009). Maintaining a degree of control often decreases the level of threat that cheetahs are perceived to pose to livestock, and as such is likely to increase tolerance toward cheetahs (Boast et al., 2016; Dickman, 2008). Although few studies published quantitative data on stock losses before and after predator translocations, those that did have shown conflicting and often inconclusive results (Linnell et al., 1997). Farmers generally perceive predator translocations to be ineffective at reducing stock losses (Boast et al., 2016), and the majority of farmers who resort to this method, request removal of other cheetahs within a short timeframe. For example, Weise et al. (2015) found that 64% of farmers (n = 14) requested the removal of additional cheetahs within 2 years of the first animal being removed. These repeated removals have the potential to create a population sink, which results in vacant territories and increased home ranges of resident cheetahs (Marker, 2002), potentially compromising the viability of the source population. Vacant territories, in turn, encourage immigration of new individuals, which as observed with the removal of pumas (Teichman et al., 2016), may increase the risk of human–predator conflict. Removing predators is counterproductive to encouraging landowners to coexist with large carnivores on their land, and the impact of repeated removals on wild populations was the primary reason the compensation–relocation program in South Africa was suspended (Marnewick, personal communication cited in Weise et al., 2015).

As a result, translocation conducted to reduce human–carnivore conflict is unlikely to be justified in areas, such as in southern and eastern Africa where cheetah populations rather than individuals are the management units (Boast et al., 2016; Fontúrbel and Simonetti, 2011; Linnell et al., 1997; Massei et al., 2010; Weise et al., 2015). However, for critically endangered populations, where every individual is crucial, human-cheetah conflict translocations are likely to remain a valuable tool.

An alternative is to use wild-born cheetahs that have been held in captivity (e.g., orphaned cheetahs or injured adults that have been rehabilitated). The instinct to hunt is innate and rehabilitated orphaned cheetahs show hunting, killing, and feeding behaviors similar to those of wild conspecifics (for details of the rewilding methodology, refer to Houser et al., 2011 and Marker et al., in preparation). Several releases of captive-raised, wild-born cheetahs have been documented (Adamson, 1969; Houser et al., 2011; Marker et al., in preparation; Weise et al., 2015). At the end of 2015, there were 160 wild-born captive cheetahs registered in the International Cheetah Studbook in Namibia alone (Marker, 2016); most were orphaned or placed in captivity due to human-wildlife conflict. Returning suitable individuals to fenced reserves (within a metapopulation) or to free-ranging environments would enable these cats to contribute to the gene pool, reduce the pressure on captive facilities, and allow the reintroduction of cheetahs into new populations without the risk of depleting existing wild cheetah populations (Marker et al., in preparation). The reintroduction of rehabilitated cheetahs requires intensive postrelease monitoring, possibly including supplementary feeding (Marker et al., in preparation; Marnewick et al., 2009). Rehabilitated cheetahs have also been reported to choose inappropriate prey resulting in potential injury, they lack experience identifying danger, and they are potentially more susceptible to infectious diseases due to limited previous exposure (Jule et al., 2008). As a result, they generally have a lower chance of survival compared with those born and raised in the wild (Chelysheva, 2011; Hayward et al., 2007a; Jule et al., 2008; Marnewick et al., 2009; Weise et al., 2015) (Table 20.1). Also, the extended captive care of rehabilitated cheetahs often results in their habituation to humans, which is associated with a greater potential for human–carnivore conflict and poorer survival in free-ranging environments (Bauer, 2005; Weise et al., 2015).

Captive-bred cheetahs, although another abundant source of cheetahs that can be rehabilitated for release into the wild (Ferguson, 1993; Pettifer, 1981), are not well suited for release as they have usually been exposed to intense human contact and have never witnessed any wild behavior from conspecifics. The release of these animals can be justified only as a last resort and only from reputable breeding programs using individuals with a known genetic background (Chapter 22).

Interactions with Resident Cheetahs: Disease and Genetics

Cheetahs from different regions are likely to have been exposed to different pathogens and parasites (Castro-Prieto et al., 2012), including those found in domestic felines and canines (Munson et al., 2004). To avoid cheetahs spreading or acquiring disease through translocation, it is important to know the disease status of the translocated individual(s) and recipient populations. Translocated individuals should be screened for infectious disease and should be free of obvious health or reproductive impairments.

Cheetahs are genetically very similar (Chapter 6), and animals pertaining to the same subspecies should be able to be translocated between populations. Even when introducing cheetahs into a small isolated population, the risk of inbreeding depression (if the population was not reinforced) is expected to outweigh the risk of outbreeding depression, potentially imposed by introducing cheetahs. However, in some cases, it will not be feasible to source cheetahs for reintroduction from the same subspecies. For instance, the remaining population of Asiatic cheetahs (*A. jubatus venaticus*) in Iran is too small to sustain any offtake for reintroduction into other areas of the subspecies' former range. If cheetahs are absent from the area that is to receive translocated animals, as is the case in India, the only consideration relates to the chance of survival of the translocated individuals in their new environment. Given the relatively short separation time between cheetah subspecies (e.g., 4,700–67,400 years ago between *A. jubatus jubatus* and *A. jubatus venaticus*) (Charruau et al., 2011), extreme differentiation leading to the inability to survive in the new environment is not likely to have arisen between the extant cheetah subspecies.

If a remnant cheetah population needed supplementation from another subspecies (i.e., genetic rescue), additional factors become relevant. The available prey populations, the number of resident animals, and the level of genetic differentiation between the source and target population must be assessed. The number of animals released, as well as the length of time they remain in the population must be carefully considered to avoid new individuals outcompeting the existing ones, leading to a shift from one subspecies to the other, rather than a genetic rescue. Two successful genetic rescues were executed in the puma (*Puma concolor*) and lion, where a puma population in Florida and a lion population in Hluhluwe-iMfolozi Park were reinforced with females originating from Texas and Etosha National Park, respectively. As a result, animal numbers increased, and inbreeding correlates declined significantly (Johnson et al., 2010b; Trinkel et al., 2008); genetic heterozygosity was measured in the Florida puma and was found to have doubled (Johnson et al., 2010b). It is important to note that hybrid animals might not benefit from the same protection status under IUCN as individuals of a pure subspecies do (Fitzpatrick et al., 2015; O'Brien and Mayr, 1991).

Optimal Number of Cheetahs for Release

To determine the optimal number of cheetahs for release to ensure the long-term persistence of a reintroduced population, a population viability analysis (PVA) needs to be conducted for the release site. A PVA uses different demographic parameters to estimate survival probabilities for a population while retaining a specified level of genetic diversity (Chapter 38). For example, to maintain 90% genetic diversity 20 years after the proposed release of four males and four females into the Bangweulu wetlands in Zambia, it would be necessary, at a minimum, to reinforce the initial population with another four males and four females every other year for 4 years (Marker, 2010). The optimum number and scheduling of cheetahs to be reintroduced is likely to vary with characteristics of the release site or metapopulation (e.g., prey availability, resident cheetah population) and, therefore, needs to be part of future site feasibility studies.

Group Composition of Cheetahs for Release

Female cheetahs are primarily solitary, and while they can be released with dependent cubs, this is likely to put extra demands upon the female when trying to establish a new home range. Male cheetahs occur either solitary or in coalitions of two or three, rarely four males (Chapter 9). Coalitions of males are more likely to hold a territory and to keep that territory for longer than singletons both in the wild (Caro, 1994) and in reintroduced populations (Hunter, 1998b). Therefore, it is desirable for male cheetahs to be released as coalitions (of two to three males), rather than individuals, to increase their chances of establishment (Fig. 20.1). Given the limited number of cheetahs released when forming a new population of reintroduced animals, it is recommended to use nonrelated individuals (Moritz, 1999). These coalitions can be formed in captive-holding facilities (see Marnewick et al., 2009 for methods used to create artificial coalitions). Relations established during the prerelease period of captivity can be strong and remain stable after release until the death of the animals (Hayward et al., 2007b; Marker et al., in preparation). Females destined for release have also successfully bonded under captive circumstances (Marker et al., in preparation). Full social compatibility of group members

FIGURE 20.1 **Coalition of two male cheetahs released in Botswana.** *Source: Lorraine Boast, Cheetah Conservation Botswana.*

before the release is likely to increase the survival rates of each of its members after the release (Somers and Gusset, 2009).

Method and Timing of Cheetah Release

To reduce intraspecific competition, it has been advised that cheetah male groupings should be released simultaneously in different parts of the reintroduction site (Hayward et al., 2007b). Subsequent cheetah releases should be outside of the established territories of previously released or resident cheetahs (Hunter, 1999), thereby giving cheetahs a chance to establish themselves and recover from the relocation stress before facing territorial conspecifics. In fenced areas, female cheetahs should be released before males (Marnewick et al., 2009). However, in unfenced environments, Marker et al. (in preparation) recommend releasing males first, while female cheetahs remain held in a holding-pen as an "anchor." When this method was tested in the NamibRand Nature Reserve, an introduced male coalition of cheetahs explored and marked the territory but continued to return to the pen holding the females. Once released, females are likely to scent mark in similar areas as the males, keeping all cheetahs in the same general area, at least during the initial critical postrelease period.

Using a holding-pen to temporarily hold translocated animals while they acclimatize to the release area is known as soft release, as opposed to animals that are released directly into the reintroduction site (hard release). In general, the soft release of carnivores is associated with less postrelease movements and stress than occurs during hard release (Teixeira et al., 2007), subsequently resulting in increased survival (Linnell et al., 1997; Massei et al., 2010; Somers and Gusset, 2009). However, as cheetahs naturally exhibit wide-roaming movements, soft-released cheetahs are still likely to move beyond the boundaries of the release site (e.g., protected area) (Houser et al., 2011; Purchase and Vhurumuku, 2005; Weise et al., 2015) and, therefore, ensuring the suitability of habitat beyond the release site remains crucial for the long-term success of reintroductions.

Postrelease Monitoring of Cheetahs

Determining reproductive and overall success of reintroduction programs requires long-term, targeted, and intensive monitoring of both the reintroduced individuals and their impact on the environment. Monitoring is an essential part of the adaptive management process and is critical to improve the success of the reintroduction program (Gusset, 2009). Cheetahs should ideally be monitored daily during the initial few weeks to ensure they are hunting successfully (Marnewick et al., 2009). Veterinary intervention, if required, is most likely to be necessary during this period. For the release of rehabilitated cheetahs, the need for intensive monitoring (several times a day to several times a week) is likely to be prolonged relative to wild-caught cheetahs, and supplementary feeding will be necessary initially. The intensity of monitoring can be reduced in the long term.

Monitoring has been made easier with the use of satellite GPS collars, which send regular GPS

FIGURE 20.2 **Translocated cheetah in Namibia showing the GPS tracking collar.** *Source: Cheetah Conservation Fund.*

positions of animals (Fig. 20.2) (Chapter 32). However, without visual follow-ups of individuals, it is challenging to determine the health and well-being of the individual and assess the outcome of the translocation (Boast et al., 2016; Wolf et al., 1996). There are also animal-welfare considerations with the use of GPS collars; collars can be fitted only to adult cheetahs, it is advisable the collar weight does not exceed 400 g, the collar must be removed or drop-off at the end of the study, and ultimately the collar should not compromise the cheetah's survival.

Postrelease monitoring substantially increases the costs of any reintroduction program; for example, 56%–60% of the estimated costs to translocate cheetahs relate to monitoring expenses (Boast et al., 2016; Weise et al., 2014). As a result, many programs neglect postrelease monitoring, or limit it to only a few months after the reintroduction of animals (due to both time and financial constraints) (Gusset, 2009). However, the importance of long-term monitoring has been highlighted by the IUCN SSC Reintroduction Specialist Group (Armstong and Seddon, 2007). Weise et al. (2014) found that monitoring expenses were the cost item that the public was most willing to fund, making long-term monitoring feasible as long as it is properly budgeted.

Support from Surrounding Communities

Surrounding communities' attitudes toward the reintroduction of cheetahs are likely to be mixed. Residents farming livestock or game animals are likely to be concerned that such reintroductions will impact their livelihoods, while landowners conducting ecotourism may welcome the reintroductions. Educational workshops, site visits, and involving local residents in the program will be necessary at potential release sites to listen to and ease people's concerns (Hayward et al., 2007b; Weise et al., 2015). Residents may need to be assured that cheetahs are not a threat to human life and should be offered advice on what to do if they see a cheetah. Providing assistance to improve livestock husbandry to protect livestock against predators and offering compensation in cases where it can be proven that a released cheetah has killed livestock, might improve residents' attitudes toward the release (Weise et al., 2015). Communicating the whereabouts of released cheetahs to the owners of the land where they roam has also shown to improve land-owners' interest in and attitudes toward released animals (Weise et al., 2015). If communities can obtain a tangible benefit from the cheetah's presence, for example, through photographic tourism, they are more likely to support its release (Lindsey et al., 2009b). Obtaining the backing of the surrounding communities is necessary for the long-term success of translocations and for the protection of the species and its habitat, and the importance of local human attitudes should not be overlooked (IUCN SSC, 2013).

Financial Costs of Reintroductions

The average cost of translocating a single cheetah in Namibia or South Africa was approximately US $2730 (Marnewick et al., 2009; Weise et al., 2015), excluding fixed costs, such as holding-pens and capture cages. The individual conservation cost of translocating cheetahs in

Namibia, defined as "the cost of one successfully translocated individual [success was defined as a nonhoming individual surviving to at least 1 year postrelease while causing minimal conflict (≤5 livestock per year)] adjusted by costs of unsuccessful events of the same species," was US $6898 (Weise et al., 2014). The authors found that most of these expenses were recovered through fundraising and in-kind donations of veterinary services and vehicles. The cost of translocations substantially increases if extended captive care or the rehabilitation of captive or orphaned cheetahs is necessary (Houser et al., 2011; Marnewick et al., 2009; Weise et al., 2014). The cost of the prey animals consumed by reintroduced predators is an additional factor to be considered (e.g., on private game reserves) (Hayward et al., 2007b). However, the costs of reintroduction programs are unlikely to be a limiting factor; indeed, in some areas the cheetah's presence is also likely to provide a source of revenue from photographic tourism (Lindsey et al., 2007). While these expenses represent a significant proportion of the budget of non-government organizations, it is a small cost to pay if it is a successful conservation action.

FUTURE PLANS FOR THE TRANSLOCATION OF CHEETAHS

In light of a growing need for the strategy, potential release sites for reintroduction have been identified across the cheetah's historical range, in Asia and Africa. In Asia, plans to reintroduce cheetahs into free-ranging environments in Uzbekistan, Turkmenistan, and India have been discussed (Breitenmoser, 2002; Marker, 2012; Ranjitsinh and Jhala, 2010). However, to date, the potential release sites do not meet the habitat requirements for the reintroduction of cheetahs, primarily due to a lack of prey. In Africa, cheetah experts identified approximately 2.7% of the cheetah's historical range in southern Africa and 1.6% of its historical range in north, west, and central Africa as recoverable land (IUCN/SSC, 2012; RWCP and IUCN/SSC, 2015). These recoverable areas were defined as being sufficiently large with suitable habitat and prey for the reintroduction or natural colonization of cheetahs within 10 years, if reasonable conservation action was taken. No recoverable range was identified in East Africa (IUCN/SSC, 2007). Areas identified as recoverable in north, west, and central Africa included parts of Senegal, Cameroon, Benin, Chad, Democratic Republic of the Congo, and Egypt (IUCN/SSC, 2012). In southern Africa, recoverable areas were identified in Angola, Malawi, Mozambique, South Africa, and Zambia (RWCP and IUCN/SSC, 2015). Plans for cheetah reintroductions into southern Africa are part of a regional project known as "painting the map red," so called because red is the color used to denote resident range in the cheetah status and action plan documents (Cheetah Rangewide Programme, 2011). To date, the only area for which a feasibility study has been conducted is the Bangweulu flood-plains in Zambia; the area was found to be suitable for cheetah reintroduction (Marker, 2010), but cheetah releases have not yet taken place.

CONCLUSIONS

As the cheetah continues to decline in numbers and distribution, the need for cheetah translocation and reintroduction programs becomes stronger. Securing habitat for the cheetah remains the priority both in terms of safeguarding existing habitat and securing new habitat within the species' historical range for recolonization and potential reintroduction. Introducing connector populations to aid natural dispersal is likely to become a major conservation management tool in the future, if cheetah populations continue to become smaller and more fragmented. Cheetahs have been reintroduced into fenced reserves with great success in South Africa. However, fenced reserves require intensive management as a metapopulation and should only be promoted as a model in regions where there is no scope for maintaining a viable free-ranging population long term. The tools that have been developed, and the lessons learned from reintroduction into fenced reserves, can be applied to future metapopulation management and, where applicable, to reintroductions into free-ranging environments.

Potential reintroduction sites for cheetahs need to be evaluated carefully and comprehensively, with an emphasis on existing predator populations and the suitability of the greater landscape for cheetah survival and population connectivity. Feasibility studies need to be conducted for all potential release sites so that reintroduction programs can be prioritized according to the local/regional endangerment of cheetahs and the area's suitability for reintroduction. Investment into postrelease monitoring and techniques to reduce/manage postrelease movements need to be emphasized.

If cheetah populations continue to dwindle, the need for reintroduction programs will increase. Although the emphasis should remain on protecting existing free-ranging populations, it is essential that reintroduction techniques have been, and continue to be, developed to aid the survival of translocated cheetahs.

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