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The long-term viability of current lion conservation strategies: A role for ex situ reintroduction

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Abstract

As the global human population increases, pressure on wildlife and habitat intensifies. Surveys chart the rapid decline in free-ranging African lions (Panthera leo). Available habitat shrinks, forcing lions into smaller and more fragmented populations. In situ attempts to protect and restore habitat and lions are rightly the mainstay of conservation effort for this species. However, they are relatively new and dependent on donor funding. It remains an empirical question as to whether current in situ conservation efforts will provide sufficient success on a continent-wide scale to maintain genetically diverse and viable lion populations before the species becomes critically threatened with extinction. In areas where populations are dramatically reduced or extirpated, wild-to-wild translocations have been adopted to reintroduce the species or support dwindling numbers. Comparisons of wild-to-wild versus ex situ reintroduction strategies for a range of species have led to a prioritising of wild-sources for the African lion on the basis of apparent superior success rate of such methods and apprehension over the effects of captivity on animals for wild-release. This paper outlines some concerns with such evaluations, questions claims of 'unequivocal success' for wild-to-wild translocations, and suggests that the African lion may now fulfil IUCN technical requirements for ex situ reintroduction.

Key Words: *African lion (Panthera leo), conservation, reintroduction, ex situ, in situ, translocation*

1. Introduction

The IUCN classification for the African lion (Panthera leo) is 'vulnerable'. A recent survey estimate 32,000 – 35,000 free-ranging lions remain in 67 areas across Africa, concluding there is "abundant evidence of widespread declines and local extinctions" even in protected areas (Riggio et al, 2012, p.18). Whilst African lion populations may exist in sufficient numbers to support this 'vulnerable' conservation status, it is the speed of the decline as a result of geographical fragmentation, climate change, increased human-wildlife conflict, inbreeding depressions, disease and the impact of trophy-hunting that is worrying. The IUCN states, "A species population reduction of approximately 30% is suspected over the past two decades (approximately three lion generations)" (in Bauer et al., 2008). Current conservation strategies have focused on in situ practices to protect and restore what's left or reintroduce from wild source populations. As threats to the African lion intensify, the use of wild-to-wild translocations has increased to supplement dwindling populations and reintroduce them back into areas where they have become extirpated. In this paper we contend that whilst these practices offer some success in restoring lion populations, it would be precarious to solely rely upon them. The speed of overall decline still outstrips these conservation efforts as numbers continue to fall. It is our argument that ex situ reintroduction of the African lion should now be seriously considered as a further conservation strategy to help restore the species in the wild. The IUCN advises that:

> *"The reality of the current situation is that it will not be possible to ensure the survival of an increasing number of threatened taxa without effectively using a diverse range of complementary conservation approaches and techniques including, for some taxa, increasing the role and practical use of ex situ techniques. If the decision to bring a taxon under ex situ management is left until extinction is imminent, it is frequently too late to effectively implement, thus risking permanent loss of the taxon…Priority should be given to the ex situ management of threatened taxa and threatened populations of economic or social/cultural importance"*
> *(IUCN, 2009a).*

It is our contention that the increasing threat to the survival of the African lion, coupled with its economic and social importance, means this is an example of a taxon that should be considered for ex situ management.

As the human population has burgeoned where lions range, threats to its existence have intensified, and have contributed to the species' eradication in some countries. Such rises reflect global trends. Between 1800 and 2011 the world's human population increased from 1 billion to 7 billion. This population is estimated to increase by 227,252 people per day (Population Institute, 2011). On current trends, the UN estimates the 8 billion mark will be reached before 2030. In sub-Saharan Africa, human population growth and subsequent land conversion is occurring at a rapid rate (Msuha et al., 2012). The human population of sub-Saharan Africa accelerated from 229 million (1960) to 863 million (2010), and is anticipated to reach 1.753 billion by 2050. This has consequences for the future of the African lion, which finds itself confined to ever decreasing and fragmented areas. As a large-bodied mammalian carnivore, the lion is a species most affected by anthropogenic disturbance as their need for large home ranges becomes curtailed and their prey base diminishes (Msuha et al., 2012). Carnivores directly conflict with humans as they depend upon similar resources (Woodroffe, 2000). For example, Fa et al. (2002) estimate 3.4 million metric tonnes of game meat is extracted from Central Africa annually, which would be sufficient to feed 2.5 million carnivores throughout the region. At the top of the trophic chain carnivores have come to characterize a paradox; revered for their magnificence yet despised for the threat they pose to humankind (Chardonnet et al., 2010).

Diminishing habitat and prey base is included within a catalogue of threats faced by the African lion. As lions find themselves increasingly in contact with humans, their fate is partly determined by the 'wildlife acceptance capacity' of their human neighbours (Carter et al., 2012; Chardonnet, 2010). Living alongside lions carries risks (Fa et al., 2002). Clarke's (2012) review of people injured or directly killed by lions in African regions includes the infamous Tsavo man-eaters responsible for the deaths of 28 railway workers in 1898, the 35 people killed in the Rufiji district of Tanzania between 2002-2004, and Craig Packer's estimation of 120 people who are attacked by lions across Tanzania every year. Livestock predation, actual or perceived, can result in retaliatory killings of lions depending on cultural sentiments and farmers' attitudes to lions (Kissui, 2008; Schumann et al., 2012). Amongst the Maasaï people, the practice of Olkiyioi (retaliatory killing) has proliferated. Hazzah and Dolreny (2007) estimate that between 2001-2006 over 140 lions died as a result of Olkiyioi in the Amboseli-Tsavo ecosystem.

As lion populations decrease, fragment and come into increasing contact with humans, threats of disease, endemic and epidemic, intensify. Inbreeding heightens the risk of endemic disease, and having human neighbours escalates the threat of epidemic disease (Trinkel et al., 2011). Reports within the literature include the outbreak of morbillivirus, most probably originating from domestic dogs, within the lion population in the Serengeti in 1994. This outbreak claimed 35% of the Mara Lion Conservation Unit (Roelke-Parker et al., 1996). Bovine tuberculosis (bTB) originating in domestic cattle led to mortalities in the Kruger National Park lion population (Keet et al., 2004). Ferreira and Funston (2010) have concluded that the presence of bTB may be negligible at present in this population, but prevalence in the population could be adversely affected by drought.

Whether the consumptive sport of trophy-hunting has a detrimental effect upon lion populations is a debateable. Across Africa the reported average annual lion off-take is 600 (predominantly male) lions through tourist hunting (IUCN, 2009b). A review of CITES reports for declared trophies between 1975 – 2008, revealed a doubling of lion trophies every 7.2 years. Furthermore, the value of the trophy increases as the species threat status is upgraded, resulting in increased hunting pressure on felids (Palazy et al., 2011). Some researchers and practitioners uphold trophy-hunting as a positive conservational tool. Such support is based upon claims that trophy-hunting protects habitat, generates revenue for poor communities, and provides funds for anti-poaching units (Deere, 2011; Lindsey et al., 2012). However the IUCN (2009b) report that the economic returns to local people from trophy hunting operators has been minimal, employment opportunities poor, and the wildlife within hunting areas is less well conserved and more susceptible to outside pressures (such as poaching) than in protected non-hunting areas. For example, Zimbabwe's CAMPFIRE programme (established 1981), generates income predominantly through trophy-hunting from which a dividend is paid to communities. In recent times, this initiative has seen a drop in revenue, a decline in the allocation of generated money to wildlife management and conservation, delays and underpayments to communities, and increased pressure on natural habitats due to worsening socio-economic conditions within the country (Frost & Bond, 2008; Taylor, 2009). In Mutandwa and Gadzirayi's (2007) survey of rural communities who should benefit from CAMPFIRE, most respondents stated they had not benefited in terms of employment and/or improved infrastructure, and had not received a cash dividend from the project since 1997.

Other work highlights the negative impact trophy-hunting has for pride structure and behaviour on those that remain. For example, the harvesting of adult male lions at Luangwa National Park in Zambia led to widening control of females by those male lions that remained, giving rise to long-term genetic and reproductive consequences (Yamazaki, 1996). Hunting around the boundary of Gwaii Intensive Conservation Area (ICA) led to a 'vacuum effect' as male lions from the park were drawn to the areas where numbers of male lions were dwindling (Loveridge et al., 2009). Recommendations have been made to the hunting industry to try and mitigate any negative impact their practices may have. Packer et al. (2010) advises that trophy hunters restrict the off-take to male lions ≥ 6 years of age, to avoid rapid reductions in lion populations. However, this figure assumes the age at which a male lion holds pride tenure is 4 years of age, giving them 2 years to reproduce. This has been challenged in further studies of southern African lions, where the mean age of pride tenure is 7.8 years and lions ousted from their first pride went on to take over ones and reproduce (Nicholls et al., unpublished report). Moreover, the guide offered to hunters for estimating a lion's age using nose colouration (Whitman & Packer, 2007) has been deemed an unreliable indicator of age in southern African lions (Nicholls et al., unpublished report).

It is against this backdrop of threats that lion conservation practices are developed and evaluated. Here we discuss current in situ and wild-to-wild reintroduction conservation strategies, and argue ex situ practices are now required to complement and extend these efforts.

2. In Situ Lion Conservation

The IUCN SSC Cat Specialist Group define the goal of in situ conservation efforts for lions:

> *"To secure and where possible, restore sustainable lion populations throughout their present and potential range within…Africa, recognizing their potential to provide substantial social, cultural, ecological and economic benefits" (2006).*

To this end, in situ conservation efforts for African lions have focused on protecting and restoring habitat, mitigating human-wildlife-conflict (HWC), educating local people about the ecological importance of lions, and providing economic benefits to those communities who live alongside them. Part of this involves changing people's attitudes towards lions. This is a daunting task as attitudes are influenced by an array of complex factors including religion (Hazzah et al., 2009), education (Schumann et al., 2012), and economics (Fa et al., 2002; Hemson et al., 2009; MacDonald & Sillero-

Zubiri, 2002). Translocating 'problem' lions is typically not an option owing to homing behaviour, anthropogenic threats on release, and not being cost effective (Chardonnet et al., 2010; Fischer & Lindenmayer, 2000; Fontúrbel & Simonetti, 2011; Treves & Karanth, 2003). As such, communities must learn to live with lions if the species is to have a viable future. In situ conservation initiatives have therefore attempted to resolve HWC and restore habitat through culturally appropriate means, involving community participation and employment for the local people.

Examples of well-established practices include the Maasailand Preservation Trust (established 1992) and its collaborator Lion Guardians (established 2007). Located in the Amboseli-Tsavo ecosystem, these initiatives work directly with the Maasaï to develop culture-appropriate methods for protecting and restoring lion populations in the area. These initiatives train and employ local people in conservation biology methods to engage in lion research, locate missing livestock, discourage retaliatory lion killings, prevent poaching, restore habitat and manage natural resources. Practices such as herding livestock by day and securing in reinforced bomas by night ('living walls') reduce the likelihood of predation by lions. The Maasailand Preservation Trust includes a compensation scheme from the Predator Conservation Fund to reimburse farmers who lose livestock to lions. These initiatives report success in terms of reductions in retaliatory lion-killings since they began, and in some cases, a shift in attitudes towards lions (Hazzah et al., 2009). Despite this much-needed work and success, questions can be asked about the long-term financial viability of such schemes, which are reliant upon donor funding. Further, if the donor funding dries up to pay salaries, would attitude change towards lions be maintained?

Firstly, the effectiveness of compensation schemes to protect wildlife across a range of taxa have been debated in the literature. Rather than protecting wildlife, compensation schemes can prove detrimental to it. They can encourage poor husbandry practices (Maclennan et al., 2009), thus putting wildlife at greater risk of retaliation. However, Bulte and Rondeau (2007) argue that if compensation payments are made conditional upon good husbandry practices then such schemes can work. There is the danger that compensation schemes may foster a culture of attributing livestock losses to lions regardless of whether this is the case or not (del Valle, 2004; Dickman et al., 2011; Nyhus et al., 2009). As such they require appropriate training to ascertain genuine cases and payments need to be delivered rapidly to farmers to prevent the likelihood of retaliation. Moreover, the perpetual cost of compensation can prove expensive and may not be sustainable in the long-term

(Dickman et al., 2011; Nyhus et al., 2009). Dickman et al., (2011) comment that compensation schemes may create poverty traps, as people move into areas where they exist, resulting in increased competition for pastoral. They conclude, "Evidence from the field suggests they (compensation schemes) are unlikely to produce substantial benefits in terms of long-term conservation or poverty alleviation, and may even have negative consequences" (Dickman et al., 2011, p. 13940).

Secondly, the practice of herding livestock during the day is not an absolute deterrent to an opportunistic hunter such as the lion (Valeix et al., 2012). Moreover, the use of reinforced bomas to secure livestock at night may not prove impenetrable to a determined carnivore (Treves and Karanth, 2003).

Finally, there is the issue of financial cost. Donor support is typically the source of funding for these initiatives, which can be unreliable, and is unlikely to be sustainable at the scale they're required. For example, the Born Free Foundation price a reinforced boma for one household at GB£1,200 (US$1, 940). Taking Zambia as an example of a southern African country with a total population of 13.4 million (World Bank, 2012), 60% of the population live in rural areas. Of this, an estimated 236, 097 households exist in the lion areas as identified by Riggio et al. (2012) (Liuwa Plains, Kafue, Sioma Ngewzi, Nsumbu-Kaputa, Luangwa), of which 68% keep some form of farm animal (Pica-Ciamarra et al., 2011). The cost of bomas in these areas would be US$311,459,162 (GB£192,655,152). Similarly, if we consider Tanzania (total population, 45 million in 2011) (World Bank, 2012) and just the 1,701,215 households in areas deemed to be at medium or high risk from lion conflict (Mesochina, 2010), of which 60% have livestock (Cavorrubias, 2012), the cost of bomas for 1,010, 729 households, is US$1,960,814,260 (GB£1,212,874,800). These figures are without taking into account the countries growing rural population, funding for compensation schemes, or money to employ local people to monitor lion movements. The financial resources required for this initiative in just one of these African countries, outstrips the entire NGO conservation expenditure across sub-Saharan Africa. An estimate of collective annual expenditure of the 25 conservation NGOs operating in Zambia is US$5,495,338, and for the 36 NGOs in Tanzania is US$14,488,729. The total expenditure of NGOs across sub-Saharan Africa is estimated at US$200,936,102 (Brockington & Scholfield, 2010; Scholfield & Brockington, 2009). This raises serious questions about the long-term feasibility of this strategy across Africa.

High on the conservation agenda are attempts to link and protect isolated lion populations. As natural re-colonization increasingly requires emigration from an occupied area, often through an inhospitable habitat matrix (Ebenhard, 1991), opportunities for recovery have been diminished. In an attempt to address this, the practice of enlarging protected areas and dropping dividing fences has resulted in the establishment of Transfrontier Conservation Areas (TFCAs), or 'Peace Parks', and trans-national wildlife corridors. Their creation has received wide support as a conservation tool to re-establish migratory routes and address issues linked to small fragmented populations, such as genetic inbreeding and demographic stochasticity.

Although the creation of TFCAs and wildlife corridors is welcomed, some problems have been noted. These include the possible spread of epidemic and endemic disease into naïve populations, increased contact with humans (poachers, hunters, farmers) and domestic animals, and the possibility of the spread of fire (Hess, 1996; Simberloff & Cox, 1987). With respect to lions, data on the presence and impact of endemic diseases within wild populations, such as FIV and FeHV is scant meaning the consequences of transmission between populations is not yet fully understood (Bull et al., 2002, 2003; Craft, 2010; Packer et al., 1999; Pecon-Slattery et al., 2008; Troyer et al., 2004; van Dyk, 1997). Riggio (2011) offers an excellent review of the current status of wildlife corridors in Tanzania, reporting threats to their existence, and implications for the African lion. The effects of human encroachment, land conversion, and major roads upon existing corridors have led to their reduction in size, and in some cases imminent disappearance. The success of TFCAs and wildlife corridors depends on local community support and trans-national dialogue at all levels. Socio-political issues can stall plans for trans-national corridors if they are viewed as commercial enterprises rather than ecologically-driven ones. For example, they can be perceived as facilitating a process of land-grabbing from local communities by conservationists and tour operators (Duffy, 2005). Consequently, the long-term viability of wildlife corridors is complex and uncertain.

The implementation of buffer zones to protect wildlife has received mixed reviews depending on their definition and use (Martino, 2001; Prins & Wind, 1993). They can be a strategy to prevent human disturbance to habitat and wildlife, or an opportunity to integrate them (Martino, 2001). Case studies suggest the former is more successful than the latter. For example, increases in numbers for the Asiatic lion (Panthera leo persica) and prey in the Gir Forest are attributed to the relocation of pastoral communities outside protected lion habitats (Singh & Gibson, 2011). However, the forced *movement of communities has a long history of negative consequences (Treves & Karanth, 2003). In an attempt to alleviate declines in wildlife from poaching, 36 buffer zones in the form of communally-owned Game Management Areas (GMAs) were established in Zambia in 1998 (Simasiku et al., 2008). The objective was to employ local people within them to protect wildlife in the area by means of regulated trophy-hunting and/or photographic tourism. The reality has been low employment of local people and continued reduction in wildlife due to hunting practices, poaching and a lack of developed photographic tourism operations (Becker et al., 2012; Simasiku et al., 2008). The mortality of lions in Zambia's GMAs is now considered unsustainable (Becker et al., 2012). Intensifying human encroachment and land conversion, fire and deforestation have threatened GMA wildlife populations further (Simasiku et al., 2008).*

Considering the complex issues in situ conservation strategies must negotiate, it is perhaps unsurprising that the list of in situ objectives detailed in IUCN conservation strategies have not yet been met. Detailed empirical research is needed to evaluate the strengths and limitations of in situ conservational techniques, such that lessons can be learned and implemented to achieve those objectives. The progress made by in situ strategies is arguably not yet outstripping the rate of decline for the African lion. This is especially true for those areas in which lion numbers are dwindling or have become extirpated.

3. Wild-to-Wild Lion Translocations

The practice of wild-to-wild translocations has been adopted in conservation to augment and restore populations and, in some cases, resolve HWC (Hunter et al., 2007, 2012; IUCN, 1998; Kleiman, 1989; MacKinnon & MacKinnon, 1991; Sarrazin & Barbault, 1996; Seal, 1991; Stuart, 1991; Tear et al., 1993). The practice of reintroducing lions to resolve inbreeding problems such as those experienced in the Ngorongoro Crater and Hluhluwe-Umfolozi Park has received support as a conservation tool (Hunter & Slotow, 2000; Packer et al. 1991). These practices have been established in lion conservation since 1991 in South Africa, Namibia, Zambia, Malawi, Zimbabwe and Mozambique, and although they tend to involve small numbers, they have occurred at about the rate of 1 per year since 1994 (Hunter et al., 2007). Accounting for 15% of the total national South African lion population (Slotow & Hunter, 2009), wild-to-wild translocation has been considered an 'unequivocal success' (Hunter et al., 2012) in terms of the number of post-release surviving animals and increased local *populations. For example between 1992–2003, 15 wild lions were released into Phinda game reserve, resulting in 4 lions later translocated in South Africa, and 3 surviving lions remaining at Phinda (Hunter et al., 2007). Stander (2003) states the successful reintroduction of 3 lions in the Kalahari Game Reserve, with their settlement into normal patterns of behaviour. Hoare and Williamson (2001) describe the commercially-driven reintroduction of lions into a photographic safari area of Bumi in Zimbabwe after the local community had eliminated them. The presence of lions in that area 4 years later is taken as a measure of success. Hunter et al. (2012) report >450 lions in South Africa by 2007 as a result of reintroduction.*

However, statements of success should be treated cautiously. In a literature review of published carnivore translocations, Fontúrbel and Simonetti (2011) note the apparent 36-48% achievement rate may reflect a publication bias for success case studies. As the highest mortality rates in translocated carnivores include felids, this "cast(s) doubts regarding the use of translocation as a conservation-sensitive tool" (Fontúrbel & Simonetti, 2011, p. 221). However, it has been argued this is prevalent in hard-releases rather than those using soft-release (Hunter et al., 2007). Nevertheless, fatalities are documented in soft-releases. For example, of the 15 lions translocated into Phinda Game Reserve between 1992-2003, anthropogenic factors led to the deaths of 3 lions that were destroyed after they killed a tourist and a further 5 lions killed in snares (Hunter et al., 2007). Of 16 lions translocated to Hluhluwe-iMfolozi Park (HiP) between 1999-2001 to supplement a small inbred population, 8 had died by 2004 (of which 1 was euthanized because of the risk of HWC, 1 euthanized due to emaciation, and 2 disappeared presumed dead). Of the 5 lions translocated to Liuwa Plains between 2008-2011 to re-establish a lion population, 1 male died in the boma, 1 male was shot, and 1 female was killed in a poacher's snare (African Parks, 2011).

Concerns surrounding wild-to-wild translocations include inadequate assessment of the community's wish to be involved, time and financial cost (approx. $3,941 ± $1,242 per felid) (Fontúrbel & Simonetti, 2011), wildlife managers' motivations for reintroduction (not typically conservation-led but commercially-driven) (Sarrazin and Barbault, 1996),

and inadequate assessment of carrying capacity (based on what is desirable rather than ecologically possible), decisions made at the incorrect social scale meaning conservation of the species across areas is not considered, isolation of reserves, disregard for genetic variation and a limited genetic pool for wild-source lions (Hunter et al., 2007, Slotow & Hunter, 2009; van Dyk, 1997). Hunter et al.

(2007) note that the three source populations for translocated lions, Kruger, Kgalagadi Transfrontier Park and Etosha NP, are probably closely genetically related, and asks for "conservatism in planning lion reintroductions".

To guard against genetic inbreeding some previous reintroductions have included prides of unrelated females and unrelated male coalitions, where social cohesion is induced by means of holding the lions in a boma and tranquilisers are used prior to release (van Dyk, 1997). This strategy has produced chequered results. Kilian and Bothma (2003) report the failure of this method to generate a social and cohesive pride. Five lions reintroduced to the Welgevonden Private Game Reserve in South Africa, split into their kin-ship groups post-release resulting in inbreeding. Trinkel et al. (2008) note the failure of reintroduced females to bond with inbred native pride members in Hluhluwe-iMfolozi Park (HiP), and recommend this strategy is not used for future releases. Unfortunately, detailed evidence of the short and long-term effects of these particular practices for prides and individual lions, prior and post-release, remain scant. For example, social network analyses of interactions within social prides focus upon the differing role each animal within the group has for social cohesion. Sih et al. (2009) argue this is especially important in fission-fusion societies, where the removal of a keystone individual can cause instability, aggression and the break-up of the group. The extent to which wild-to-wild translocation practices engage in such analyses before removing individuals, and the effects of such removals upon the rest of the pride, is not yet discussed in the literature. Furthermore, as a territorial species, the impact of translocated lions upon the host population warrants detailing.

Additionally, endemic and epidemic diseases within lion populations need to be carefully considered in wild-to-wild translocations and wild-source founders. Conversely, it has been argued that this has not been a feature of practices involving terrestrial social carnivores and could result in a 'conservation disaster' (Craft, 2010). For example, the presence of bovine tuberculosis (bTB) within the wild-source lion population at Kruger NP is concerning (Winterbach et al., 2000). A 4-year monitoring project of 16 lions infected with bTB in southern Kruger, and 16 uninfected lions, revealed 5 of the 16 infected lions died directly of the disease. A further 7 of the infected group died due to disruption in the pride as a result of death of prominent pride members from TB (Keet et al., 2004). Long-term effects of bTB on the lion population have yet to be evidenced, which may have implications where Kruger NP lions are a founder source for in situ reintroduction. The presence of *bTB in HiP lions reduced the population from 84 individuals to 20, between 2000-2004, most of which are descended from translocated lions (moved between 1999-2001) from Pilanesberg and Madikwe (Trinkel et al., 2008). Continued management is also required to prevent inbreeding in this small population (Trinkel et al., 2008), which numbered an estimated 130 lions in 2010 (Hluhluwe Game Reserve). It is claimed that given sufficient space, prey, and in the absence of disease and HWC, lion populations can recover quickly as a result of translocation (Chardonnet et al., 2010). Unfortunately, to date there is no clear evidence to support this. Declarations of 'unequivocal success' for wild-to-wild translocations in lion conservation remain problematic in the context of increasing threats and mixed results*

4. Ex Situ Reintroduction

In the context of threats, rapid declines, and limitations of current conservational strategies for the African lion, it is our contention that it is time to consider ex situ reintroduction. Researchers have argued that ex situ reintroduction now needs to be implemented more generally within species conservation (Chardonnet et al., 2010; IUCN, 2009a; Mallinson, 1995). However, reviews of reintroduction attempts per se report low success rates. Assessing 116 reintroduction studies, Fischer and Lindenmayer (2000) report 30 successes, 31 failures and 55 unknown results. Beck et al., (1994) reviewed 146 ex situ reintroductions, of which only 16 are reported as successful. Such figures go some way to explaining why arguments for ex situ of the African lion may be written off before any discussion.

There is a danger in accepting publications of reintroduction attempts as representative of the field. They can be problematic due to biases in publication of successes, a lack of long-term data, and discrepancies in what constitutes success (Fischer & Lindenmayer, 2000; Kleiman, 1989; Ostermann et al., 2000). Whilst for some projects success is based on whether there are any surviving individual animals after a short period post-release (e.g. Shier & Owings, 2006), for others it is the protection of a habitat regardless of whether any individuals survived (Kleiman, 1989), statistical equivalence with wild populations for survival and reproduction of released individuals (Cheyne, 2012), or the establishment of a large self-sustaining population (Beck et al., 1994). The scale at which success is measured may not be appropriate for the species under consideration.

Where failures for ex situ reintroduction have been reported, the reduced likelihood of animals surviving post-release (as opposed to in situ reintroduction) is attributed to the modification of *temperament traits and behaviours as a consequence of captivity and human imprinting, the inability of reintroduced individuals to respond adequately to competitive species and predation (Jule et al., 2008; McDougall et al., 2006). Ex situ programmes also stand accused of focusing on genetic variation at the expense of social traits and behaviours (Sarrazin & Barbault, 1996) and offering an impoverished environmental enrichment (Newberry, 1995).*

However, amongst this apparent catalogue of failings there are some success stories and lessons learned along the way. For example, group cohesion is key for successful ex situ reintroductions for social species, although this has not yet had the opportunity to be tested (Kleiman, 1989). The importance of behaviour enrichment in captive-origin individuals, such as lion cubs, has been emphasised in facilitating social cohesion and natural pride behaviours (Ncube & Ndagurwa, 2010). Shier and Owings (2006) noted the importance of pre-release predator training in their successful ex situ reintroduction of prairie dogs (based on post-release survival after 1 year). Other case studies of successful ex situ reintroductions from captive (zoological park) founders include the Arabian oryx (Oryx leucoryx) (Stanley Price, 1989), the American red wolf (Canis rufus) (Philips & Parker, 1988), black-footed ferrets (Mustela nigripes) (Russell et al., 1994), and golden lion tamarins (Leontopithecus rosalia) (Beck et al., 1991).

Success stories aside, wild-to-wild translocations and in situ conservation approaches have been prioritised and institutionalised in conservation science over ex situ reintroductions, meaning that attempts to discuss, develop, fund and publish ex situ work is problematic (Pritchard et al., 2011). As such, trying to establish a rigorous programme of ex situ conservation for the African lion becomes problematic. It is difficult to assess if this will work when attempts are few, and opportunities for doing so remain limited. Existing ex situ reintroduction programmes for lion conservation are dismissed on the grounds of funding and conservational impetus (regarded simply as tourist attractions) (Pritchard et al., 2011), lack of published success, and unwarranted assumptions about how lions are handled and 'who' is reintroduced into the wild (e.g. Hunter et al., 2012; Abell & Youldon, 2013; Hunter et al., 2013). As a result ex situ reintroduction has been effectively disregarded on the basis of having no conservational merit (Hunter et al., 2012), without being given the opportunity for success. However, in the context of intensifying threats, decline, and the inevitably slow progress of current conservation strategies, ex situ reintroduction now needs to be given the chance. This is especially the case in those areas where lion populations are dangerously low or have become extirpated.

Whilst in situ practices rightly continue to define lion conservation there are obstacles that need to be negotiated to ensure their long-term viability. In the meantime lion populations continue to decline. For example, whilst Kenya is one of the few countries with >1,000 lions, the Kenya Wildlife Service (KWS) reports over 100 lions have been lost from the country every year since 2002 (Kenya Wildlife Service, 2012). KWS estimate extinction of wild lions from the area within 10 years. In other words, the speed of overall decline is outstripping the rate at which in situ conservation practices can be implemented.

For ex situ programmes to be recognised as part of a worthwhile effort to conserve lions, negative perceptions of them will need to abate and success (and failure) evaluated appropriately within a suitable time-frame. Captive bred animals are a logical source for reintroduction programs in instances where wild populations are precluded from translocation and reintroduction programs due to genetic incompatibility and disease prevalence. Captive populations can be secure and free from disease. Time can be factored in for communities, wildlife managers, conservationists, researchers, business leaders and policy-makers, who all have vested interests in the existence (or elimination) of lions to be properly consulted and solutions monitored long-term. Captive lions can be easily bred in sufficient numbers and in an environment where the species can easily acclimatize to release.

Lawrence Frank (cited in Barley, 2009) states that 'drastic action' is now needed to prevent further wildlife loss from Africa. Perhaps one virtue of being deemed controversial is that ex situ reintroductions may now be considered 'drastic' enough to implement. The IUCN technical guidelines for ex situ management are based on fulfilment of one or more of the following Red List criteria: "When the taxa/population is prone to effects of human activities or stochastic events or When the taxa/population is likely to become Critically Endangered, Extinct in the Wild, or Extinct in a very short time. Additional criteria may need to be considered in some cases where taxa or populations of cultural importance, and significant economic or scientific importance, are threatened" (IUCN, 2009a). We argue that in the context of the causes and speed of decline for the African lion, ex situ reintroduction should now be considered.

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