Response to the March 2011 petition to the list African lion (*Panthera leo*) as endangered

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Executive summary

1. We reviewed the literature in response to the March 2011 petition to list the African lion as endangered pursuant to the United States Endangered Species Act, to determine if such a listing is warranted and what the implications of such a listing might be for lion conservation generally.
2. We found that the African lion population decline has not been as dramatic as is frequently reported, and that in recent years the population decline has slowed and may have ceased.
3. Lion populations inside most protected areas that are lion strongholds have remained stable over the past 30 years at least.
4. Most lions now occur both inside of large protected areas and in population strong holds.
5. Lion populations in fenced reserves are thriving and frequently need to be controlled.
6. A smaller proportion of wild lions now occur outside of protected areas and are at higher risk of decline. Lions occurring outside of protected areas are primarily found in trophy hunting areas.
7. The main threats to African lions include loss of habitat, pre-emptive and retaliatory killing by livestock owners, and poaching aimed at other species. Overutilization through trophy hunting or commercial trade is not currently a major threat to African lions. There are, however, increasing cases of over hunting and steps should be taken to increase the monitoring and regulation of hunted populations.
8. There is no evidence that population declines that occur outside of protected areas will extend into protected areas, and African lions are therefore not currently at risk of extinction. Based on these findings we conclude that such a listing is not warranted.
9. Furthermore, we find that there is wide spread concern amongst the scientific community that the listing of the African lion as endangered might impede the ability of stakeholders to utilise lions to generate financial income mainly through trophy hunting. Whilst it is acknowledged that such a listing would not specifically ban trophy hunting of lions, it is also noted that the overwhelming majority of lion trophy hunters are U.S. citizens and if they were prevented from importing lion trophies into the U.S. then a significant portion of the client base and potential earnings through the utilisation of African lions would be lost. A perceived loss of value could also be detrimental to African lions.
10. We therefore also conclude that the listing of the African lion as an endangered species by the USFWS will have damaging consequences for the conservation of African lions in the wild and conservation efforts should rather be aimed at increasing the research and monitoring of strategic populations and reforming hunting activities where necessary.

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1. Introduction

This document serves as a collection of scientific evidence regarding the status of the African lion in response to the March 2011 petition to list the species as endangered pursuant to the United States Endangered Species Act.

We endeavour to illustrate two main points; first, the listing is not warranted under the outlined criteria for listing a species as endangered, and secondly, that the listing of African lions as an endangered species would have damaging consequences for the conservation of African lions in the wild. There is no significant trade in African lions and the largest threats that the species faces are poaching, loss of habitat, and human wildlife conflict, not unsustainable utilisation through trophy hunting. The listing of the sub species as endangered will not reduce the threat from the major causes of the African lion population decline.

Nothing currently prevents the U.S. government from providing African range states with assistance in conserving wild lions, nor does anything prevent the petitioners and/or conservation organisations from heightening awareness with foreign governments and the general public regarding the importance of conserving lions. These are listed in the petition as the main benefits to the sub species of listing it as endangered.

It should be noted from the beginning that a 2009 report to the Born Free Foundation (one of the petitioners), specifically advises against campaigns either aimed at upgrading African lions from CITES appendix II to CITES appendix I, or linked mechanisms such as the U.S. Endangered Species Act, due to the damaging consequences such an action would have for lion conservation. The report also demonstrated how trophy hunting would be replaced by damaging land use practices should it be prevented by far reaching regulations such as those that could be imposed by the U.S. Endangered Species Act.

This document begins with a review of the current status and distribution of African lions. Each of the five factors under which a species may be determined to be threatened or endangered according to the amended 1973 Endangered Species Act are dealt with in turn. This document concludes with two detailed case studies of major conservation success stories for the African lion and explores how such a listing might affect these populations.

2. Status and distribution

Our current best estimate of the size and distribution of the African lion population comes from Riggio et al. (2012), according to whom between 32 000 and 35 000 African lions remain on about 3.4 million km^2 of African savannah habitat. Most of these lions live in large protected areas (about 19 000) and occur in population strongholds (about 24 000) with a further 4000 occurring in potential strongholds (Riggio et al. 2012). It is estimated that about half of Africa's lions are found in Tanzania (Frank et al. 2006), where they benefit from an extensive network of protected areas and large tracts of sparsely populated habitat (Baldus 2004). Tanzania has between 250 000 and 300 000 km^2 of habitat set aside for commercial trophy hunting, much of which is inhabited by African lions (Frank et al. 2006; Lindsey et al. 2007), and similar areas are found in Mozambique (82 000 km^2), Zambia (160 488 km^2) and Zimbabwe (65 000 km^2).

The March 2011 petition submitted to the United States Fish and Wildlife Service (USFWS) is largely based on the perceived decrease in the numbers of African lions over the past three decades. In the petition it is also argued that this decline is ongoing. This claim is misleading and exaggerated for a number of reasons. The figure of 75 800 is taken as the bench mark for the decline in lion numbers since 1980. This was calculated in one unpublished study (Ferreras and Cousins 1996) who used a modeling exercise to estimate what the lion population may have been 16 years previously, and no actual counts were carried out at that time. Given the difficulty of estimating lion numbers even in the present (Stander 1998; Loveridge et al. 2001; Chardonnet 2002; Ferreira and Funston 2010), this theoretical number should not be used as the basis for important conservation decisions.

The 2012 (and previous) IUCN review of the African lion acknowledged that the Ferreras and Cousins (1996) model may have been an overestimate. Furthermore, much of the data used to calibrate the model was collected in the 1960's and 1970's. As a result, this estimate may better reflect the population in 1970 rather than 1980. In this way the decline of the African lion population may have been both slower and less dramatic than it is made out to be in the petition.

More accurate counts were carried out in the early 2000s by Chardonnet (2002) and Bauer and Van Der Merwe (2004), who estimated the lion population to be 39 000 (range 28 854 – 47 132) and 23 000 (range 16 500 – 30 000) respectively. The average of these two estimates is 31 000 free ranging lions in Africa in the early 2000s, which is comparable to the most recent and comprehensive estimate by Riggio et al. (2012), who estimated the lion population to be between 32 000 and 35 000; approximately 33 500. This strongly suggests that African lion numbers have remained stable over the past decade, and contradicts the petition's assertion that lions are in a continuous and precipitous decline. Riggio et al. (2012) attributed this to a difference in the methodologies used to estimate lion numbers, but do not adequately explain how counts from the early 2000s give similar figures to our current best estimate if lions have remained in continuous decline.

In addition, the heavily cited Ferreras and Cousins (1996) report estimates that there were around 18 600 lions inside protected areas in 1980. This would have been the most accurate prediction of the model since this is where there has been the least change in land use and the most stable lion populations (Packer et al. 2005a; Ferreira and Funston 2010; Packer et al. 2010; Funston 2011a; Funston et al. *in prep.;* Packer et al. *in press*). This figure is comparable with the 19 000 estimated by Riggio et al. (2012). We thus confidently conclude that though individual populations may have fluctuated, there has been no substantial overall decrease in the number of lions inside most large African protected areas in the past 32 years.

Whilst there may be a threat to lion populations that occur outside of protected areas, lions still occur in almost all of eastern and southern Africa's major National Parks and after spotted hyena, lion remain the most abundant large predator in African savannah ecosystems (Estes 1999). Even if populations outside of protected areas decline, there is no good reason to believe that this trend will extend into protected areas. There is therefore no evidence to suggest that lions are currently at risk of extinction, particularly because the largest populations are in large protected areas (Macdonald and Loveridge 2010b).

In addition to the fact that lion numbers appear to be remaining stable in recent years, is the fact that the majority of lions currently occur both in protected areas and in population strongholds. According to the petition, only 9 879 lions (average of middle estimates for Chardonnet 2002 and Bauer and Van Der Merwe 2004) are found in population strongholds and these are spread across five population clusters, a mere 30 percent of the approximate total population. In contrast the more recent Riggio et al. (2012) study estimated that 24 000 lions (approximately 75 percent) occur in 10 strongholds throughout Africa, with a further 4 000 occurring in potential strongholds.

The main reason for the discrepancy in the number of lions occurring in strongholds is the definition of what constitutes a population stronghold. The petitioners use Traill et al.'s (2010) viability threshold as the criteria for classifying lion populations. In this way it is implied that populations falling below a particular threshold cannot be considered to be of importance in the long term. Traill et al.'s (2010) suggestions may well be useful in certain contexts, however there are underlying assumptions that these populations are isolated from any immigration and emigration. Given the tendency of lions to disperse across vast areas (Schaller 1972), this is unlikely to be the case for most populations. For example, the lions of the Savé Valley Conservancy (SVC) were exterminated during the 1900s but naturally recolonized this area once the main land use converted to trophy hunting (Funston 2011b). An extreme example of the dispersal abilities of lions is one male from Hwange National Park that managed to cover more than 150 km and crossed the mighty Zambezi River before reaching Livingstone in Zambia (pers. com. Loveridge 2012).

Even more problematic is the assumption of no translocation. Whilst this is a sensible and even useful inclusion in Traill et al.'s (2010) model, it cannot be ignored when making management decisions and assessing the conservation value of a population. As large carnivores go, African lions are one of the easiest to capture, even entire prides may be caught at a time using relatively safe capture drugs and procedures (Smuts et al. 1977). There are many examples of highly successful translocations and reintroductions of wild lions, which is now a common place management intervention in several Africa countries (see Hunter 1998; Slotow and Hunter 2009; Kettles and Slotow 2009; and BVC and SVC case studies).

However strongholds are defined, the value of populations that fall below Traill et al.'s (2010) cut off point cannot be ignored. Managing a number of small populations as a larger meta-population is a real possibility, and one way of guarding against the risk of extinction. The use of "insurance populations" was recommended by Jones et al. (2007) as a means of protecting Tasmanian devils from the risk of extinction due to the emergence of a new disease. A network of reserves forming an effective metapopulation effectively conserves wild dogs and cheetahs in South Africa (Davies-Mostert et al. 2009). This approach protects the population as a whole from the risk of extinctions due to stochastic events such as disease related die offs (Young 1994). According to Young (1994) herbivores are more susceptible to die offs due to starvation and these are better avoided whilst in large continuous populations. Conversely, carnivores remain more susceptible to die offs due to disease, and are better protected from these by population subdivision (Young 1994). This is not taken into account by the petition, and the numerous small, isolated but well protected lion populations should be considered to be of significant value.

Lions are "thriving" in all fenced areas and are frequently removed by managers because of over population (Kettles and Slotow 2009; Packer et al. *in press*; Miller et al. *in press*). Lions in all fenced areas are expected to persist into the next century and their populations frequently exceed the carrying capacity of the fenced reserves (Hayward et al. 2007; Packer et al. *in press*). This further demonstrates that African lions are not in danger of extinction, and that there are a large amount of lions available to be reintroduced into areas where they have been exterminated. This also demonstrates the potential to sustainably utilize lions through trophy hunting, which can be used to generate funds for conservation efforts (Lindsey et al. 2007) and to control expanding populations (e.g. Funston 2011b). The need to utilize lions outside of protected areas to generate financial income is large because of the huge cost associated with protecting them. It is estimated to cost over US$ 1000/km^2/year to maintain an unfenced population at just 50 percent of its potential size, and even in fenced populations it is estimated to cost at least US$ 500/km^2/year to successfully protect this species (Packer et al. *in press*).

Finally, it should be noted that the IUCN convention reviewed the status of African lions in 2012 and reached the decision to maintain their status as vulnerable (Nowell et al. 2012). The petition does not include any new major research findings that were not included in the comprehensive IUCN assessment, and there is therefore no new reason to alter the status of African lions as defined by the USFWS.

3. Natural history and basic biology of the African lion

We have no serious disagreement with the petitioner's summary of the basic natural history and biology of the African lion, and therefore have no wish to repeat it. However, it is important at this stage to highlight the incredible capacity that lions have to breed and increase their numbers rapidly if given a sufficient prey base and provided with adequate protection (Smuts et al. 1978; Loveridge et al. 2007b; Kettles and Slotow 2009). This aspect of their biology is often overlooked and problems associated with high densities of lions arise quickly under these circumstances (Smuts 1978; Frank et al. 2006; Hunter et al. 2007; Loveridge et al. 2007b; Kettles and Slotow 2009; Packer et al. *in press*.)

Trophy hunting is one means by which lion populations can be controlled and this has the advantage of generating financial income that may be used for conservation purposes (Lindsey et al. 2007; Lindsey et al. 2012). In the absence of trophy hunting culling may be the only realistic option for controlling lion numbers in larger areas as the use of contraceptives is likely to be inefficient and expensive. In South Africa it has now become common practice for managers to cull excess wild lions in the more than 45 reserves in which they have been introduced (Miller et al. *in press*). This is largely due to fears about public sentiment associated with trophy hunting and resulted in the wasteful destruction of about 200 lions in 2011/12.

In the absence of regulating lion populations that increase to undesirable densities, the impacts on both the herbivore and mesopredator communities can be severe (Funston 2011b). This is particularly undesirable when it impacts on rare, endangered, and threatened species and lions have been documented to adversely affect African wild dog (Creel and Creel 1996), cheetah (Kelly and Durant 2000), and leopard (du Preez unpublished), and predation by lions reportedly reduced the roan antelope population in

Kruger National Park (KNP) to virtual local extinction (Harrington et al. 1999). We are of the opinion that this is a relevant issue that needs to be considered when assessing; a) the status of the African lion, and b) the impact of changing its status to endangered, as this may set a precedent that could affect the ability of managers to control lion populations, particularly as this may impact on species that are currently of greater conservation concern than African lions, such as African wild dog and cheetah.

4. Criteria for listing the African lion as endangered

4.1. Threatened destruction, modification, curtailment of habitat or range

Introduction

Loss of habitat due to human agricultural expansion (and both preemptive and retaliatory killing by livestock owners) is one of the biggest threats to African lions throughout their range, but particularly in West Africa (Bauer et al. 2010; Macdonald and Loveridge 2010a; Riggio et al. 2012). The habitat available to African lions has undoubtedly declined from pre-colonial times. According to Riggio et al. (2012), only 1.36 million km^2 of Africa's savannahs are inside formally protected areas. This is around 10% of the original 13.5 million km^2 of African savannah habitat. This is, however, more or less in line with the 1993 IUCN target for habitat conservation (IUCN 1993). Although lions do not occur in all areas that are formally protected, they do occur in the majority of them (Riggio et al. 2012).

General

In order to fully understand the threat of loss of habitat available to African lions it is important to examine where lions currently occur and what habitat is available to them, and thus where they could potentially occur. It is also important to ensure the continued protection of habitat in all protected areas, even those from which lions have already disappeared. Restoration was identified as of key importance by the 2006 Lion Conservation Strategy Workshop and it was stated that range states that have lost their lions should not be allowed "off the hook" (Nowell and Bauer 2006). Lion translocations and reintroductions can be extremely successful if carried out carefully (Hunter et al. 2007; Slotow and Hunter 2009; Funston 2011b; Kettles and Slotow 2009; see also BVC and SVC case studies), and once the route cause of a local extinction has been removed, reintroductions are a very viable option for expanding lion populations. In the case of West Africa, provided that a small but genetically viable West African population can be conserved (either in captivity or in the wild), patience and habitat protection may be the only solution to the current threat to lions in the region.

Lions are large and dangerous carnivores, and living alongside them is challenging for local communities that must face the real threat that lions pose to both their lives and livestock (Baldus 2004; Packer et al. 2005b; Woodroffe and Frank 2005). It therefore comes as no surprise that lions are generally exterminated in areas that are heavily settled, and this includes most land uses other than wildlife (Baldus 2004; Woodroffe and Frank 2005). Thankfully, large areas still exist outside of formally protected National Parks, on which wildlife is utilized as the primary source of income and African lions still occur in many of these (Baldus 2004; Lindsey et al. 2007; Riggio et al. 2012). In addition to the 1.36 million km^2 of protected areas, a further 1.4 million km^2 is dedicated to hunting (and is therefore

"land under wildlife"), doubling the amount of land that is either occupied, or is potentially available to African lions (Riggio et al. 2012).

A thorough review of the current distribution of lion populations and the threats they face was conducted by Loveridge and Canney (2009), who concluded that any action that could result in a blanket ban on the recreational trophy hunting of African lion would be detrimental to the conservation of the sub species. This is because of the consequential loss of habitat that would occur when trophy hunting is replaced with less wildlife compatible land use practices such as subsistence agriculture and livestock production (Loveridge and Canney 2009). In southern Kenya lions face local extinction as a result of retaliatory killing by local communities in response to livestock depredation (Hazzah et al. 2009). Such habitat may be available to lions if the attitudes of local communities could be influenced, and Romanach et al. (2007) found that community members would increase tolerance towards lions if they were able to derive an income from them through trophy hunting or ecotourism.

Even if wildlife continued to be the primary land use, a decision that prevented lions from being utilized through trophy hunting would still be detrimental to the species since they would lose their financial value and relevant stakeholders would have no financial motivation to protect the species, or even tolerate its presence (Lindsey et al. 2012). For example, cheetah now have little value as a hunting species, and wildlife veterinarians are frequently contacted by land owners in Namibia to remove cheetah from their properties because they prey on cattle and more valuable herbivore species (pers. com. Haw 2012), and presumably many are simply shot by land owners.

The vast majority of areas under wildlife generate all of their financial income via trophy hunting, which is the most profitable form of consumptive wildlife utilization (Lindsey et al. 2007), and in many areas is the only viable option (Lindsey et al. 2006b). The recent emotional, negative sentiments towards trophy hunting should not be considered here, as the status of the African lion is a conservation issue and not an ethical one. If the ethics of hunting are to be debated then this courtesy should be extended to all species, and the U.S. Endangered Species Act should not be abused for this purpose.

Despite the ongoing controversy between the relative conservation contributions of ecotourism and trophy hunting, it should be noted that huge areas of land are dedicated to trophy hunting (Baldus 2004; Lindsey et al. 2007; Packer et al. *in press*). The level of management in these areas varies greatly with some areas undeniably exploited and others reflecting high levels of protection. It should be accepted that at least in some instances trophy hunting has measurable conservation benefits. For example, Bubye Valley Conservancy (BVC) is a privately owned hunting conservancy in southern Zimbabwe that derives all of its income from trophy hunting. Though rhino are not hunted on BVC, it is home to Zimbabwe's largest population of black rhino, and the fifth largest population of black rhino in the world (pers. com. Anderson 2012), and the proceeds from lion hunting are at least partially used to offset the cost of anti-poaching efforts on BVC (pers. com. Leathem 2012).

The notion that relevant stakeholders face a choice between consumptive trophy hunting and non-consumptive ecotourism needs to be seriously challenged, as this is central to the issue of habitat available to African lion outside of protected areas. Following Botswana's recent total ban on all hunting, and Zambia's temporary ban on all hunting and permanent

ban on lion and leopard hunting, the respective ministers for both countries stated that photographic operations would take the place of safari hunting and implied that this would be good for the conservation of local wildlife. Underlying criteria for successful ecotourism include an abundance of wildlife and attractive scenery (Lindsey et al. 2007), and these are generally not characteristics of hunting areas. Areas that cannot provide these may not be able to continue with wildlife as the primary land use, or afford the comprehensive anti-poaching bills that are associated with the basic protection of wildlife (Lindsey et al. 2009; Packer et al. *in press*).

Furthermore, ecotourism may frequently have higher negative environmental impacts than trophy hunting (Lindsey et al. 2007), and this fact is often overlooked. Trophy-hunting areas tend to be large, to very large, and require only a small volume of high paying individuals to visit them, and so there is a strong argument that many areas are better conserved by trophy hunting than ecotourism (Lindsey et al. 2007). Trophy hunters also tend to be more resilient in times of political instability (Lindsey et al. 2007). For example, following the post 2000 political instability in Zimbabwe, ecotourism in the country collapsed almost immediately whereas trophy hunting operators were far less affected. For example, Senuko lodge on SVC, which is primarily a hunting conservancy, attempted to use non-consumptive ecotourism for the sole form of income in the late 1990s, but was forced to revert to trophy hunting following 98 percent cancellations of bookings post 2000 (pers. com. Groom 2013, but see SVC case study for more detail).

The relative contributions of ecotourism and trophy hunting can however be considered a side issue. The important point is that many trophy hunting areas cannot simply convert to ecotourism for the major source of financial income (Lindsey et al. 2006a; Lindsey 2008). More often, landowners and community stake holders face a choice between trophy hunting and cattle ranching (for example see case study BVC), or in some instances, agriculture. The result is that should new regulations render trophy hunting a less financially viable option, an area larger than the entire network of currently protected areas, and almost half the size of the United Kingdom will be at risk of being converted to land uses other than wildlife, and this currently constitutes the biggest single threat to lion habitat (Baldus 2004).

There is very little opportunity to enlarge publically protected areas. However, the amount of privately protected land is growing and is likely to continue to do so as long as it remains financially profitable (Krug 2001). Private land is important for lion conservation as many state managed parks face declining budgets and deteriorating resources (Krug 2001), particularly with the large costs associated with protecting lions (Packer et al. *in press*). In South Africa alone 44 newly established reserves protect approximately 500 lions (Miller et al. *in press*). For this reason, care should be taken when making decisions that may affect the viability of wildlife as a land use on private land.

Conclusion

In conclusion, loss of habitat is one of the biggest threats to African lion in the wild. Fortunately eastern and southern Africa has an extensive network of protected areas, and an even larger area set aside for trophy hunting supplements this. There is no current threat to formally protected areas but hunting areas face the threat of either national or international hunting bans or restrictions. Neither state protected areas nor state hunting areas are likely

to grow in the future. However, private land under wildlife is currently expanding and will continue to for some time if the necessary financial incentives to do so remain.

4.2. Overutilization for commercial, recreational, or scientific purposes

Introduction

The petitioners list extensive references to the utilization and trade of African lions and their parts over the last decade and claim that the African lion "is clearly over utilized". However, using data from the petition, range states annually exported (for all purposes) on average only 1.5% of their national populations (excluding Togo which is not a permanent range state and exported only one lion). By any standard this is remarkably low, particularly considering that almost half of the traded parts were for scientific purposes, which are generally strictly controlled by ethics committees. The majority of the samples that could be considered equivalent to a whole lion would probably have come from lions that had succumbed to natural mortality.

Commercial trade

According to Loveridge and Canney (2009), commercial trade is not currently problematic for lion populations, and in 2004 the CITES Cat Specialist Group found that there was general scientific opposition to the listing of lions on Appendix I, because lion population declines were not trade related (Nowell 2004). This is supported by the fact that lion are not actively targeted by poaching syndicates, though they are frequently killed by poachers that are in pursuit of other species (Packer et al. 2010; Begg and Begg 2012; Becker et al. 2013). Given how easily lions can be poached due to their susceptibility to wire snares and poison (Hoare and Williamson 2001; Begg and Begg 2012; Becker et al. 2013), the fact that they are not actively targeted indicates that the trade of lions and lion parts is not a large or profitable sector and is therefore not currently a major threat to African lions, though it may need to be closely monitored in the future. Though some trade in lion parts does occur, the only real consumptive value of lions is as a premier trophy hunting species (Lindsey et al. 2012).

Scientific purposes

Almost all scientific journals and modern universities require ethical approval before publishing and/or approving research projects. The slaughter of lions for scientific research is unlikely to get this kind of approval and it is misleading to suggest that lion parts exported for scientific purposes are sourced from lions that were deliberately slaughtered for these purposes. It seems probable that most of the lion parts that were exported came from natural mortalities in scientifically monitored populations. Nowhere in the literature is it suggested that the exploitation of African lions for scientific purposes is cause for concern.

Recreational (trophy) hunting

Increasing recent evidence suggests that trophy hunting of lions is having a negative impact on certain populations and numerous examples of lions being over hunted can be found in the literature (Loveridge et al. 2007b; Packer et al. 2010; Croes et al. 2011; Becker et al. 2012). However despite this, in an assessment of the role that lion hunting plays in their conservation, Lindsey et al. (2012) concluded that prohibiting lion hunting would be a

greater long term threat to lions than over hunting. Furthermore, of the major range states Kenya, Botswana and now recently Zambia, do not permit the trophy hunting of lions and significant numbers of wild lions are now only hunted for recreational purposes in four countries; namely Namibia, Mozambique, Tanzania, and Zimbabwe. Packer et al. (2006) found that lion off take quotas over the last 30 years have been too small in virtually every country to have contributed to lion decline.

There has also been a recent move within the industry itself to bring lion hunting practices more in line with good conservation. Whitman et al. (2007) showed that the negative effects of hunting on a lion population could be largely mitigated by restricting hunting to males that were 6 years and older. Dallas Safari Club has recently announced their criteria for the "ideal huntable lion" (being a male at least 6 years of age and not known to be part of a pride with dependent cubs), based on Whitman et al.'s (2007) research and demonstrates some willingness amongst the hunting community to self regulate. Niassa Reserve in Mozambique rigorously enforces the "6 year rule" (Begg and Begg 2009), and similar reforms are being mandated by law in Tanzania. Both of the two major private hunting conservancies in Zimbabwe (BVC and SVC) allow full time independent research to monitor the lion (and other carnivore species) populations.

Aside from the various national and international mechanisms that regulate trophy hunting in order to prevent over hunting, Lindsey et al. (2006b) showed that the industry in itself is self-regulating because over hunting leads to reduced trophy quality. Trends in trophy quality are used for setting quotas in many species when managers and authorities are determining future off-take quotas and a reduction in trophy quality generally leads to a reduction of the off-take quota (pers. com. Leathem 2012).

A growing number of studies have assessed the status and distribution of African lions, and whilst many of them give examples of areas in which trophy hunting has negatively impacted particular populations, most of them also highlighted the importance of lion hunting for their conservation, and none cited trophy hunting as a reason for population decline at a continent wide scale (Chardonnet 2002; Bauer and Van Der Merwe 2004; Loveridge and Canney 2009; Macdonald and Loveridge 2010a; Packer et al. *in press*; Packer et al. 2006; Lindsey et al. 2012).

4.3. Disease or Predation

Disease

According to Keet et al. (1996), disease is an increasing threat to lions due to many populations being isolated by fencing. However, Young (1994) found that carnivores are generally better protected from disease when their populations are subdivided as this can prevent the spread of disease across the entire population. Moreover, as mentioned, Packer et al. (*in press*) found that all fenced lion populations are thriving, and lions have proved to be remarkably resilient to disease. Only one significant outbreak of canine distemper virus (CDV) was sufficiently virulent to cause notable population declines during the 50 years in which the Serengeti/Ngorongoro lions have been studied.

The much publicized threat to lions of infection with bovine tuberculosis (BTb) in the KNP has not caused any substantial detrimental effects to the lion population, and although BTb

has been present in the park for sometime, the lion population has remained stable over the past 20 years (Ferreira and Funston 2010). Many lion populations appear to have an extremely high prevalence of Feline Immunodeficiency Virus (FIV), with four sampled populations having infection rates of between 70 and 90 percent (Brown et al. 1994). Despite this, serious deleterious effects of FIV have not yet been detected and there is no evidence that FIV reduces longevity in African lions (Packer et al. 1999). Herpesvirus infects 100 percent of the Serengeti lion population and no clinical signs of the disease have been found (Craft 2008). The Serengeti lion population has been intensively studied for more than 30 years and aside from the 1994 CDV outbreak, none of the other studied feline viruses (herpesvirus, FIV, feline calicivirus, feline parvovirus, and feline coronavirus) appear to have affected the birth and death rates of the lion population (Packer et al. 1999). The threat of exotic disease to the KNP lion population was also found to be negligible at present (Ferreira and Funston 2010).

Encouragingly, Begg and Begg (2012) found no evidence of disease in the Niassa Reserve that is home to between 800 and 1000 lions. There are several examples of lion population crashes due to disease outbreaks, but these are generally followed by a remarkable population recovery. An epizootic in 1962 caused the lion population in the Ngorongoro crater to crash to as few as ten individuals but this population recovered to its previous size by 1975 following 12 years of exponential growth, and there is evidence that this pattern has occurred before (Packer et al. 1991). In the Serengeti, an outbreak of CDV in 1994 caused more than 35 percent of the lion population to either die or disappear (Cleaveland et al. 2000), but the population had recovered to its former size within three years (Packer et al. 1999).

Probably the biggest current disease threat to African lions is CDV that is usually transmitted to lions from domestic dogs. There are several programs either currently in place or previously carried out, that have helped prevent this by vaccinating domestic dogs on the periphery of lion populations for CDV and rabies (Packer et al. 1999; Cleaveland et al. 2003; Begg and Begg 2012). Hunting areas acting as buffer zones on the periphery of reserves are important because it is desirable to have a lower density of lions in areas immediately adjacent to villages (Packer 1996) and it is likely that this could also help to prevent the spread of disease from domestic dogs to lion population strongholds.

Predation

As the apex predator in African savannah ecosystems (Becker et al. 2012), predation is not a threat to African lion though in some areas conflict and competition with other predators (particularly spotted hyena), may affect their survival and abundance (Cooper 1991), but rarely in any significant way.

4.4. Inadequacy of existing regulatory mechanisms

Introduction

There are a variety of local, national, regional and international regulatory mechanisms, which are designed to directly and indirectly prevent the overexploitation of African lions. As with the natural history and biology of African lions, the petition exhaustively describes these regulatory mechanisms and there is no need for them to be repeated here. It is

however pertinent to make several clarifications, and to list some of the numerous examples of where these regulatory mechanisms have been successfully employed. These typically come in the form of hunting moratoriums – and given the huge propensity of lions to breed quickly (Smuts 1978; Miller and Funston *in press*), temporary hunting moratoria can be extremely successful for aiding population recovery when over hunting is the original cause of population decline (Davidson 2009).

CITES

As stated in the petition, the most significant and specific international regulation pertaining to the protection of the African lion is the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), under which lions are listed on Appendix II. This means that the trade in African lions is already regulated by the issuance of permits by the exporting country and the inspection of those permits by the importing country.

Aside from controlling the trade in lions and lion parts, this also allows for the extensive and accurate collection of data on trade in lions (and the their parts). The CITES standing committee for African lions recently reviewed their status and found that trade was not a significant cause of their decline and there was therefore no grounds for the up-listing of African lions to Appendix I (Nowell 2004). This demonstrates how CITES is currently monitoring the trade in African lions and has the best available data for making decisions regarding the regulation of trade in African lions. At this point in time CITES has decided that the listing of lions in Appendix I is not warranted and may be detrimental. This is the result of a carefully considered process, and not the fault of an inadequate or failing regulatory mechanism.

Examples of the implementation of regulations protecting African lions

Lion hunting in Botswana

In response to growing concern regarding the lion population in Botswana, total lion moratoria were implemented between 2001 and 2004. The moratorium was reinstated in 2007, and Botswana has recently banned all commercial trophy hunting.

Hunting moratoria in Zimbabwe

For the year 2000, a hunting moratorium was placed on the Zambezi Valley in Zimbabwe following reports (mainly from tour guides and tourists) that the lion population appeared to be decreasing (Monks 2001 op cit. Davidson 2009).

Intensive lion monitoring in Hwange National Park (HNP) in Zimbabwe by the Hwange Lion Project documented an increased vacuum effect and a decline in the numbers of males in the population as a result of trophy hunting in the areas surrounding the park (Loveridge et al. 2007b). As a result of the recommendations made by lion researchers in HNP, the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) implemented a hunting moratorium in western Zimbabwe from 2005 to 2008 (Davidson 2009). Subsequent monitoring of the HNP lion population showed that the perturbation effects caused by trophy hunting were reversed during the 3 year hunting moratorium and trophy hunting was reinstated at a reduced, more sustainable quota (Davidson 2009). This is a particularly encouraging

example because it demonstrates how independent research can assist the relevant national authority in making decisions regarding the protection of African lions. It also clearly illustrates the resilience of lions to bounce back after just a short term, localized hunting ban, clearly negating the need for a permanent blanket ban.

Lion hunting in Zambia

In January 2013 the Zambian minister of tourism, Sylvia Masebo, abruptly announced the complete ban of lion and leopard hunting. According to news reports, this was in response to accusations of corruption in the wildlife department and a declining national population. Because on average less than 3.5 percent of the lion population in Zambia is hunted annually (Packer et al. 2006), it is doubtful whether trophy hunting could have caused a national population decline. Furthermore there is no substantive evidence of a national decline in Zambia, although poaching (Becker et al. 2013) and localized over hunting (Becker et al. 2012) seem to be having some local negative effects. Of concern, however, were claims in the press that the decision was an emotional one rather than a carefully considered decision. In the short term, this moratorium may help to correct perturbations in some populations caused by over hunting, however, in the long term this may only exacerbate problems associated with populations depleted by poaching.

Conclusion

There is a wide range of far reaching regulatory mechanisms that extend protection to African lions, the most important of these being CITES, which regulates the trade in threatened and endangered species. CITES has the best data and is the most relevant authority to make decisions that influence the trade in African lions and African lion parts and is closely monitoring the species. There are also numerous examples where national authorities have intervened when there has been evidence of lions being overhunted, and it is clear that there are adequate regulatory mechanisms in place to protect African lions. Impeding the ability of range states to benefit from the good management of their lions by introducing far reaching restrictions on the importation of trophies is likely to be detrimental to the sub species. Increasing the funds available for the research and monitoring of important lion populations is probably the best way to help protect the sub species, and will allow for informed decisions regarding their management to be made.

4.5. Other natural or manmade factors affecting the survival of the African lion in the wild

The petition cites retaliatory killing, compromised viability and ritual killing in this section as cause for concern. Of them, retaliatory killing is probably the most serious threat (Woodroffe and Frank 2005). However, anti-sentiment towards lions is likely to be highest in areas where lions have little or no value to local communities (Hazzah et al. 2009). Preventing the commercial hunting of African lions will likely aggravate this situation and local communities may become less tolerant of lions if they cannot derive some form of financial income from their presence (Hazzah et al. 2009).

As populations become increasingly isolated it may be necessary to monitor them for signs of compromised viability. Fortunately lions are relatively easy to capture and translocate (Hayward and Kerley 2008), and even entire prides may be captured at a time using

remarkably safe drug combinations (Smuts et al. 1977). Although social issues must be taken into account, it is very feasible to manage smaller isolated populations as part of a larger meta-population and avoid the complications of compromised viability (Miller et al. *in press*).

Ritual killings at present are not a major threat to African lions. Far more serious however, is the susceptibility of lions to be caught in the by-catch of illegal subsistence and commercial poaching (Becker et al. 2013). Lions are extremely vulnerable to wire snares, which plague much of their range (Begg and Begg 2012; Becker et al. 2013). It is our opinion that losses of lions due to wire snares and to a lesser extent poison are grossly underestimated. BVC provides an excellent example of how even relatively high off-take quotas can have virtually no effect on the population, provided that poaching is removed. BVC is probably one of the most secure game reserves in Africa due to the high level of security employed to protect the large black rhino population, including a daily patrolled double electrified fence surrounding the entire property and a large number of well armed anti-poaching personnel (pers. com. Leathem 2012). As a result, less than 20 animals were killed in wire snares in 2012 on the 2 730 km^2 of the main conservancy, but of these, four – a staggering 20%, were African lions (personal observation 2012). This highlights the extreme susceptibility of lions to wire snaring, and the possibility that lion mortalities due to wire snares are a major factor affecting their survival; both inside but particularly outside protected areas should not be underestimated. Again, this highlights the need for the species to generate money, which can be put back into its conservation through pro-active anti-poaching programs.

5. Summary and Conclusion

A thorough review of the literature reveals that the overwhelming majority of individuals who could be considered experts in the field believe that the listing of African lions as endangered is not warranted and caution that such an action could be detrimental to their conservation. The majority of these scientists do, however, believe that hunting reforms are needed and have clearly suggested how this needs to be done (Hunter et al. *submitted*). African lions have been periodically reviewed by IUCN and their status has remained unchanged as "vulnerable". CITES already strictly controls the trade in African lions through a permit system. As yet, CITES has not seen fit to list African lions on Appendix I, and the proposal to list African lions on Appendix I at the 13th conference of the parties was accordingly withdrawn. The current discussion that has been created by the withdrawn CITES proposal to upgrade lions to Appendix I, and the March 2011 petition to the USFWS, may ultimately be very beneficial to lion conservation, as this has served to highlight the importance of this iconic species. It is clearly recognised that overhunting has occurred in several lion areas and in some areas lion hunting may need to be heavily regulated or even temporarily suspended. The key actions to take are 1) to reform African lion hunting policies uniformly across the key lion hunting countries, 2) fund conservation efforts particularly of stronghold populations, and 3) increase the monitoring and research on strategic lion populations in order to address the reasons for their decline. Independent research and monitoring of lions in hunting areas would also serve to improve the regulation and conservation value of the vast areas of land dedicated to safari hunting, and may help to prevent corruption in the industry. We would like to end with a quote from a report to (and commissioned by) the Born Free Foundation:

"Lobbying for a CITES upgrade may find little justification on the basis of either over-

exploitation through trade or current declining conservation status of the African lion and it is therefore unclear that this is an effective use of resources. As outlined above it is unclear whether a successful upgrade to Appendix 1 would benefit conservation of the species. A CITES upgrade is likely to limit levels of lion trophy hunting in at least some range states, but this neglects the fact that trophy hunting may not in fact be the most serious threat to most lion populations. Trophy hunting can (and does) impact lion populations when poorly managed and poorly monitored (Loveridge et al. 2007a; Loveridge et al. 2007b). However, the benefit of wild habitat protected by well-managed and well-protected hunting areas vastly outweighs any potential problems of over-exploitation and indeed over-exploitation is unlikely in circumstances when hunting is adequately managed (Whitman et al. 2004)."

6. References

Anderson, N. (2012). Zimbabwe Rhino Monitoring Coordinator.

Baldus, R. (2004). Lion conservation in Tanzania leads to serious human-lion conflicts: With a case study of a man-eating lion killing 35 people. *Tanzania wildlife discussion paper*.

Bauer, H., K. Nowell and C. Packer (2010). Panthera leo, IUCN.

Bauer, H. and S. Van Der Merwe (2004). Inventory of free-ranging lions *Panthera leo* in Africa. *Oryx* **38**(1): 26-31.

Becker, M., R. McRobb, F. Watson, E. Droge, B. Kanyembo, J. Murdoch and C. Kakumbi (2013). Evaluating wire-snare poaching trends and the impacts of by-catch on elephants and large carnivores. *Biological Conservation* **158**: 26-36.

Becker, M. S., F. G. R. Watson, E. Droge, K. Leigh, R. S. Carlson and A. A. Carlson (2012). Estimating past and future male loss in three Zambian lion populations. *The Journal of Wildlife Management*.

Begg, C. and K. Begg (2009). Niassa carnivore project. *Produced for SRN, Maputo*.

Begg, C. and K. Begg (2012). The status of lions and their threats in Niassa Reserve.

Brown, E. W., N. Yuhki, C. Packer and S. J. O'Brien (1994). A lion lentivirus related to feline immunodeficiency virus: epidemiologic and phylogenetic aspects. *Journal of Virology* **68**(9): 5953-5968.

Chardonnet, P. (2002). Conservation of the African lion: Contribution to a status survey., International Foundation for the Conservation of Wildlife, France and Conservation Force, USA.

Cleaveland, S., M. G. J. Appel, W. S. K. Chalmers, C. Chillingworth, M. Kaare and C. Dye (2000). Serological and demographic evidence for domestic dogs as a source of canine distemper virus infection for Serengeti wildlife. *Veterinary Microbiology* **72**(34): 217-227.

Cleaveland, S., M. Kaare, P. Tiringa, T. Mlengeya and J. Barrat (2003). A dog rabies vaccination campaign in rural Africa: impact on the incidence of dog rabies and human dog-bite injuries. *Vaccine* **21**(17): 1965-1973.

Cooper, S. M. (1991). Optimal hunting group size: the need for lions to defend their kills against loss to spotted hyaenas. *African Journal of Ecology* **29**(2): 130-136.

Craft, M. E. (2008). Predicting disease dynamics in African lion populations, University of Minnesota.

Creel, S. and N. M. Creel (1996). Limitation of African Wild Dogs by Competition with Larger Carnivores. *Conservation Biology* **10**(2): 526-538.

Croes, B., P. Funston, G. Rasmussen, R. Buij, A. Saleh, P. Tumenta and H. De Iongh (2011). The impact of trophy hunting on lions (*Panthera leo*) and other large carnivores in the Bénoué Complex, northern Cameroon. *Biological Conservation*.

Davidson, Z. (2009). Lion ecology and socio-spatial impacts of trophy hunting in Zimbabwe. DPhil., University of Oxford.

Davies-Mostert, H. T., M. G. L. Mills and D. W. Macdonald (2009). A critical assessment of South Africa's managed metapopulation recovery strategy for African wild dogs. *Reintroduction of top-order predators*(5): 10.

du Preez, B. The effect of anthropogenic mortality and intra-guild competition on leopard (*Panthera pardus*) ecology, University of Oxford, Department of Zoology, Wildlife Conservation Research Unit.

Estes, R. D. (1999). The Safari Companion. Vermont, Chelsea Green Publishing Company.

Ferreira, S. M. and P. J. Funston (2010). Estimating lion population variables: prey and disease effects in Kruger National Park, South Africa. *Wildlife Research* **37**(3): 194-206.

Ferreras, P. and S. H. Cousins (1996). The use of a Delphi technique with GIS for estimating the global abundance of top predators: The lion in Africa. *Unpublished report, International EcoTechnology Research Centre, Cranfield University, UK.*

Frank, L., G. Hemson, H. Kushnir and C. Packer (2006). Lions, conflict and conservation in Eastern and Southern Africa. The Eastern and Southern African Lion Conservation Workshop.

Funston, P. J. (2011a). Population characteristics of lions (Panthera leo) in the Kgalagadi Transfrontier Park. *South African Journal of Wildlife Research* **41**(1): 1-10.

Funston, P. J. (2011b). The Save Valley Conservancy Lion Management Plan. Tshwane University of Technology.

Funston, P. J., O. Aschenborn and M. Kastern (*in prep.*). Long-term stability of African lions in Etosha National Park: do fences effectively mitigate conflict?

Groom, R. J. (2013). Mammal Research Institue, University of Pretoria, Pretoria, 0002, South Africa.

Harrington, R., N. Owen-Smith, P. C. Viljoen, H. C. Biggs, D. R. Mason and P. Funston (1999). Establishing the causes of the roan antelope decline in the Kruger National Park, South Africa. *Biological Conservation* **90**(1): 69-78.

Haw, A. (2012). Wildlife Conservation Physiology, Brain Function Research Group, University of Witwatersrand.

Hayward, M. W. and G. I. H. Kerley (2008). Prey preferences and dietary overlap amongst Africa's large predators. *South African Journal of Wildlife Research* **38**(2): 93-108.

Hayward, M. W., J. O'Brien and G. I. H. Kerley (2007). Carrying capacity of large African predators: predictions and tests. *Biological Conservation* **139**(1): 219-229.

Hazzah, L., M. Borgerhoff Mulder and L. Frank (2009). Lions and Warriors: Social factors underlying declining African lion populations and the effect of incentive-based management in Kenya. *Biological Conservation* **142**(11): 2428-2437.

Hoare, R. and J. Williamson (2001). Assisted re-establishment of a resident pride of lions from a largely itinerant population. *South African Journal of Wildlife Research* **31**(3): 179-182.

Hunter, L., P. Lindsey, G. Balme, M. Becker, C. Begg, H. Brink, A. Dickman, C. Edwards, L. Frank, P. Funston, P. Henschel, D. Ikanda, B. Kissui, N. Midlane, A. Loveridge, P. White and K. Whitman (*submitted*). Urgent and comprehensive reform needed in sport hunting of African lions. *PLOSBiol*.

Hunter, L., K. Pretorius, L. Carlisle, M. Rickelton, C. Walker, R. Slotow and J. D. Skinner (2007). Restoring lions Panthera leo to northern KwaZulu-Natal, South Africa: short-term biological and technical success but equivocal long-term conservation. *Oryx* **41**(2): 196.

Hunter, L. T. B. (1998). The behavioural ecology of reintroduced lions and cheetahs in the Phinda Resource Reserve, KwaZulu-Natal, South Africa, University of Pretoria.

IUCN (1993). World Conservation Union. Parks for life: Report of the IVth World Congress on National Parks and Protected Areas. Gland (Switzerland): IUCN.

Jones, M., P. Jarman, C. Lees, H. Hesterman, R. Hamede, N. Mooney, D. Mann, C. Pukk, J. Bergfeld and H. McCallum (2007). Conservation Management of Tasmanian Devils in the Context of an Emerging, Extinction-threatening Disease: Devil Facial Tumor Disease. *EcoHealth* **4**(3): 326-337.

Keet, D., N. Kriek, M. Penrith, A. Michel and H. Huchzermeyer (1996). Tuberculosis in buffaloes (Syncerus caffer) in the Kruger National Park: spread of the disease to other species. *The Onderstepoort Journal of Veterinary Research* **63**(3): 239.

Kelly, M. J. and S. M. Durant (2000). Viability of the Serengeti cheetah population. *Conservation Biology*: 786-797.

Kettles, R. and R. Slotow (2009). Management of free-ranging lions on an enclosed game reserve. *South African Journal of Wildlife Research* **39**(1): 23-33.

Krug, W. (2001). Private Supply of Protected Land in Southern Africa: A Reiew of Markets, Approaches, Barriers and Issues. International Workshop on Market Creation for Biodiversity and Services. Paris, Centre for Social and Economic Research on the Global Environment.

Leathem, K. (2012). Conservator and General Manager - Bubye Valley Conservancy. Section Manager, Lemco Ranch (1987-1994).

Lindsey, P., S. Romanach and H. Davies-Mostert (2009). The importance of conservancies for enhancing the value of game ranch land for large mammal conservation in southern Africa. *Journal of Zoology* **277**(2): 99-105.

Lindsey, P., P. Roulet and S. Romanach (2007). Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. *Biological Conservation* **134**(4): 455-469.

Lindsey, P. A. (2008). Trophy hunting in Sub Saharan Africa, Economic scale and conservation significance. *Best Practices in Sustainable Hunting: A Guide to Best Practices from Around the World* **201**: 41-47.

Lindsey, P. A., R. Alexander, L. Frank, A. Mathieson and S. Romanach (2006a). Potential of trophy hunting to create incentives for wildlife conservation in Africa where alternative wildlife-based land uses may not be viable. *Animal Conservation* **9**(3): 283-291.

Lindsey, P. A., G. A. Balme, V. R. Booth and N. Midlane (2012). The significance of African lions for the financial viability of trophy hunting and the maintenance of wild land. *PloS one* **7**(1): e29332.

Lindsey, P. A., L. Frank, R. Alexander, A. Mathieson and S. Romanach (2006b). Trophy hunting and conservation in Africa: problems and one potential solution. *Conservation Biology* **21**(3): 880-883.

Loveridge, A. (2012). Hwange Lion Research Project, Project Leader. Wildlife Conservation Research Unit, University of Oxford, Oxford.

Loveridge, A. and S. Canney (2009). Report to the Born Free Foundation. Report on the Lion Distribution and Conservation Modeling Project.

Loveridge, A. J., T. Lynam and D. W. Macdonald (2001). Lion Conservation Research. Workshop 1: Survey Techniques., Wildlife Conservation Research Unit, University of Oxford, Oxford, UK.

Loveridge, A. J., J. C. Reynolds and E. Milner-Gulland (2007a). Does sport hunting benefit conservation? *Key Topics in Conservation Biology*: 224-241.

Loveridge, A. J., A. W. Searle, F. Murindagomo and D. W. Macdonald (2007b). The impact of sport-hunting on the population dynamics of an African lion population in a protected area. *Biological Conservation* **134**(4): 548-558.

Macdonald, D. W. and A. J. Loveridge (2010a). The biology and conservation of wild felids. Oxford, Oxford University Press.

Macdonald, D. W. and A. J. Loveridge (2010b). Biology and conservation of wild felids, Oxford University Press Oxford.

Miller, S. M., C. Bissett, A. Burger, B. Courtney, T. Dickerson, D. J. Druce, S. Ferreira, P. J. Funston, D. Hofmeyr, P. J. Kilian, W. Matthews, S. Naylor, D. Parker, R. Slotow, T. M. and D. Zimmermann (*in press*). Management of reintroduced lions in small, fenced reserves in South Africa: an assessment and best practice guidelines. *South African Journal of Wildlife Research*.

Miller, S. M. and P. J. Funston (*in press*). Population growth rates of lions (*Panthera leo*) on small fenced reserves in South Africa: a management dilemma. *South African Journal of Wildlife Research*.

Monks, N. (2001). The Lion on the Mana Pools floodplain - are they decreasing? *Afican Hunter* **9**: 22-24.

Nowell, K. (2004). The Cat Specialist Group at CITES 2004. *Cat News* **41**: 29.

Nowell, K. and H. Bauer (2006). Eastern and Southern African Lion Conservation Workshop: Minutes Report., Johannesburg.

Nowell, K., C. Breitenmoser-Wursten, U. Breitenmoser and M. Hoffmann (2012). The IUCN Red List of Threatened Species, African lion *Panthera leo*. Available at http://www.iucnredlist.org/details/15951/0.

Packer, C. (1996). Who rules the park? *Wildlife conservation* **99**(3): 36-39.

Packer, C., S. Altizer, M. Appel, E. Brown, J. Martenson, S. J. O'Brien, M. Roelke-Parker, R. Hofmann-Lehmann and H. Lutz (1999). Viruses of the Serengeti: patterns of infection and mortality in African lions. *Journal of Animal Ecology* **68**(6): 1161-1178.

Packer, C., H. Brink, B. M. Kissue, H. Maliti, H. Kushnir and T. Caro (2010). Effects of Trophy Hunting on Lion and Leopard Populations in Tanzania. *Conservation Biology*.

Packer, C., R. Hilborn, A. Mosser, B. Kissui, M. Borner, G. Hopcraft, J. Wilmshurst, S. Mduma and A. R. E. Sinclair (2005a). Ecological change, group territoriality, and population dynamics in Serengeti lions. *Science* **307**(5708): 390-393.

Packer, C., D. Ikanda, B. Kissui and H. Kushnir (2005b). Conservation biology: lion attacks on humans in Tanzania. *Nature* **436**(7053): 927-928.

Packer, C., A. E. Pusey, H. Rowley, D. A. Gilbert, J. Martenson and S. J. Obrien (1991). Case-Study of a Population Bottleneck - Lions of the Ngorongoro Crater. *Conservation Biology* **5**(2): 219-230.

Packer, C., S. Canney, A. Loveridge, S.T. Garnett, M. Pfeifer, K.K. Zander, A. Swanson, D. MacNulty, G. Balme, H. Bauer, C.M. Begg, K.S. Begg, S. Bhalla, C. Bissett, T. Bodasing, H. Brink, A. Burger, A.C. Burton, T. Caro, B. Clegg, S. Dell, A. Delsink, T. Dickerson, S.M. Dloniak, D. Druce, L. Frank, P. Funston, N. Gichohi, R. Groom, C. Hanekom, B. Heath, L. Hunter, H.H. DeIongh, C.J. Joubert, S.M. Kasiki, B. Kissui, W. Knocker, B. Leathem, P.A. Lindsey, S.D. Maclennan, J.W. McNutt, S. Miller, S. Naylor, P. Nel, C. Ng'weno, K. Nicholls, J.O. Ogutu, E. Okot-Omoya, B.D. Patterson, A. Plumptre, J. Salerno, K. Skinner, R. Slotow, E.A. Sogbohossou, Stratford, C. Winterbach, H. Winterbach and S. Polasky (*in press*). Conserving Large Carnivores: Dollars and Fences. *Ecology Letters*.

Packer, C., K. Whitman, A. Loveridge, J. Jackson and P. Funston (2006). Impacts of trophy hunting on lions in East and Southern Africa: Recent offtake and future recommendations. Background paper for the Eastern and Southern African lion conservation workshop, Johannesburg, South Africa.

Riggio, J., A. Jacobson, L. Dollar, H. Bauer, M. Becker, A. Dickman, P. Funston, R. Groom, P. Henschel and H. de Iongh (2012). The size of savannah Africa: a lion's (*Panthera leo*) view.

Romanach, S. S., P. A. Lindsey and R. Woodroffe (2007). Determinants of attitudes towards predators in central Kenya and suggestions for increasing tolerance in livestock dominated landscapes. *Oryx* **41**(2): 185.

Schaller, G. B. (1972). The Serengeti lions: a study of predator prey relations, University of Chicago Press.

Slotow, R. and L. T. B. Hunter (2009). Reintroduction decisions taken at the incorrect social scale devalue their conservation contribution: African lion in South Africa. *The reintroduction of top-order predators*: 43-71.

Smuts, G. L. (1978). Effects of Population Reduction on Travels and Reproduction of Lions in Kruger-National-Park. *Carnivore* **1**(May): 61-72.

Smuts, G. L., J. Hanks and I. J. Whyte (1978). Reproduction and Social-Organization of Lions from Kruger National-Park. *Carnivore* **1**(Jan): 17-28.

Smuts, G. L., I. J. Whyte and T. W. Dearlove (1977). A mass capture technique for lions. *African Journal of Ecology* **15**(1): 81-87.

Stander, P. E. (1998). Spoor counts as indices of large carnivore populations: the relationship between spoor frequency, sampling effort and true density. *Journal of Applied Ecology* **35**(3): 378-385.

Traill, L. W., B. W. Brook, R. R. Frankham and C. J. A. Bradshaw (2010). Pragmatic population viability targets in a rapidly changing world. *Biological Conservation* **143**(1): 28-34.

Trethowan, P. D. (2012). Bubye Valley Conservancy Lion Research Project. University of Oxford, Department of Zoology, Wildlife Comservation Research Unit.

Whitman, K., A. M. Starfield, H. S. Quadling and C. Packer (2004). Sustainable trophy hunting of African lions. *Nature* **428**(6979): 175-178.

Whitman, K. L., A. M. Starfield, H. Quadling and C. Packer (2007). Modeling the effects of trophy selection and environmental disturbance on a simulated population of African lions. *Conservation Biology* **21**(3): 591-601.

Woodroffe, R. and L. G. Frank (2005). Lethal control of African lions (*Panthera leo*): local and regional population impacts. *Animal Conservation* **8**(1): 91-98.

Young, T. P. (1994). Natural Die-Offs of Large Mammals: Implications for Conservation. *Conservation Biology* **8**(2): 410-418.

Case study 1: Bubye Valley Conservancy (BVC) – African lion on a private hunting conservancy

1. Introduction

The little known Bubye Valley Conservancy (BVC) is one of the most remarkable conservation success stories of recent times. The most significant achievements are the establishment of large and flourishing populations of black rhino and African lion in an area that was committed to cattle ranching and the eradication of wildlife species just 20 years ago. This is an attempt to document the circumstances surrounding the formation of the conservancy and the potential future of the lion population in the context of the recent petition to the USFWS to list the sub species as endangered.

The 3440 km^{2}conservancy is situated in the lowveld of southern Zimbabwe. Public roads separate the Ripple creek and Malangani sections from the main conservancy (Figure 1). The remaining 2730 km^2 make up the 'main conservancy'. There are no internal fences within the main conservancy.

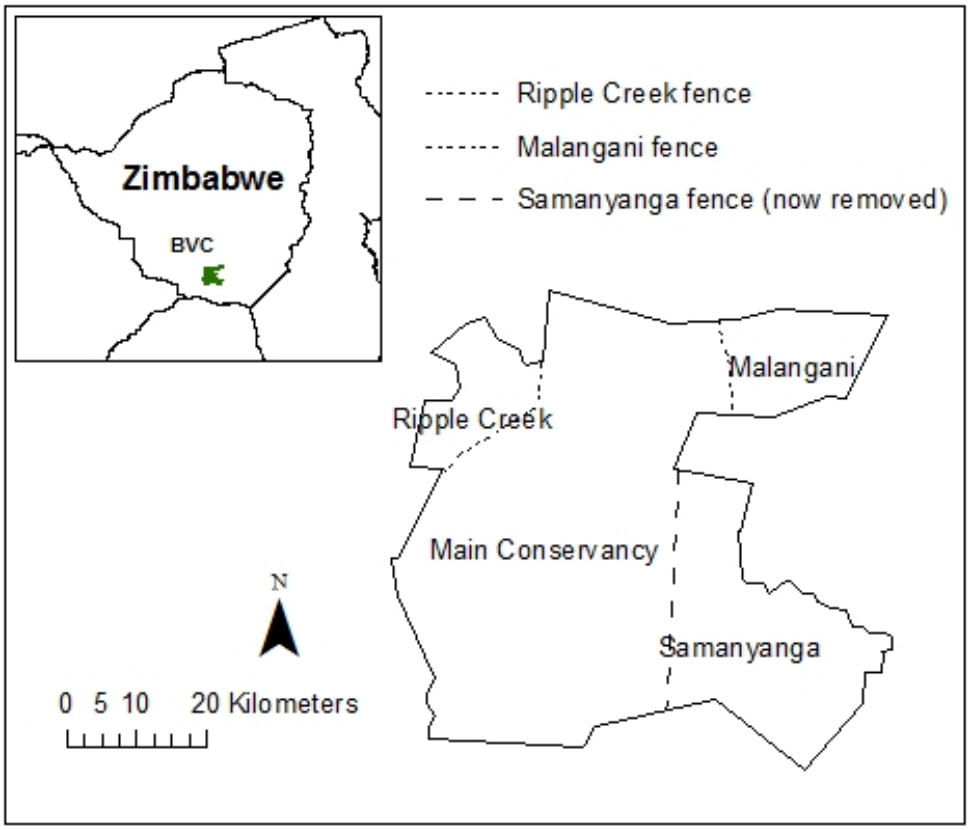


Figure 1. Map showing BVC in relation to Zimbabwe, as well as Ripple Creek, Malangani, and Samanyanga sections

Part of National Region V (Agritex. 1984), BVC is located in one of the hottest and driest areas in Zimbabwe with summer temperatures regularly exceeding 40 degrees Celcius. Mean annual rainfall recorded on the neighbouring Kleinbegin Ranch over the last 45 years is just 347 mm (appendix 1).

Mopane (*Colophospermum mopane*) woodland savannah dominates the overwhelming majority of the conservancy with some riparian (*Acacia gulpinii*) woodland occurring along the Bubye River. Though the annual rainfall is low, BVC represents a high nutrient ecosystem that supports large numbers of medium sized herbivores, particularly blue wildebeest (*Connochaetestaurinus*) and plains zebra (*Equusburchelli*). As a result, high densities of predators can also potentially be sustained. There is virtually no naturally occurring permanent surface water, but a large number of artificial water points are distributed across the conservancy.

The low rainfall, lack of permanent flowing rivers, large continuous areas of mopane woodland, and lack of notable topographical features make this area unsuitable for ecotourism.

2. Background and history of Bubye Valley Conservancy

The high nutrient system in the lowveld of southern Zimbabwe meant that there was extremely good grazing available for cattle, and at the turn of the 20th century the Liebig's Extract of Meat Company (Lemco) established a vast cattle ranch on the land that is now known as Bubye Valley Conservancy. From the onset of ranching activities, the managers of the ranch made consistent efforts to eradicate most of the indigenous wildlife (pers. com. Leathem 2012). Herbivore species were considered undesirable because they competed with livestock for grazing, and buffalo and wildebeest had the potential to transmit disease to cattle. Rewards were issued for the killing of lions, leopard, and spotted hyena to encourage the persecution of predators, in order to protect the livestock from predation. Cheetah were also removed when possible on a permit system though rewards were not issued for this species. Most indigenous wildlife species persisted at least in small numbers, but the resident buffalo, lion, and elephant had been completely eradicated by the 1990s, and black and white rhino had disappeared prior to the establishment of the ranch (Leathem 2012).

Lemco Ranch was crippled by a devastating drought in 1982/83 and this was followed by a similar dry season in 1992/93 (see appendix 1) that resulted in the ranch being sold off as it was decided to be unsuitable for cattle ranching due to the frequency and severity of droughts (pers. com. Leathem 2012).

The vast Lemco Ranch was sold to a group of shareholders who established the Bubye Valley Conservancy in 1994, following a similar transition from cattle to wildlife, and establishment of the neighbouring 1800 km^2 Bubiana Conservancy and the nearby 3400 km^2 Savé Valley Conservancy (SVC). The internal cattle fences were removed and wildlife became the primary land use on BVC, and on much of southern Zimbabwe.

3. Conversion to wildlife as a land use and consumptive vs non-consumptive utilisation of wildlife

The conversion from cattle ranching to wildlife required a huge investment. For example, a 2.1m double electrified game fence surrounding the entire conservancy was erected. This perimeter fence follows the 270 km (540 km for both fences) long boundary, and cost approximately US$ 2.1 million to erect and a further US$ 120 000/year to maintain. Though most wildlife species persisted in low numbers, many animals were either re-introduced, or

brought on at significant cost to the shareholders in order to boost existing populations. Nine safari camps were constructed and the road network improved. There are also significant running costs, and aside from fence maintenance, other notable running costs include anti-poaching (US$ 280 000), Diesel (US$ 450 000 depending on current prices, or 320 000L/year), wages/salaries (US$ 850 000 for 2012), electricity (US$ 120 000), and camp running costs and maintenance (US$ 750 000), and this demonstrates the need for a substantial income base in order to continue with wildlife as the primary land use.

The main intended form of income was always commercial trophy hunting, but the Samanyanga section (Figure 1) was initially fenced separately and dedicated to ecotourism, with no hunting allowed. However, by 2002 it had been established that ecotourism was not a viable option in the area, the partitioning fence was removed and Samayanga was included in the main conservancy. Trophy hunting then became the sole form of income for the conservancy (pers. com. Leathem 2012).

Despite the collapse of the tourism industry following negative publicity in Zimbabwe surrounding the controversial land reform program initiated in 2000, the trophy-hunting sector of the conservancy remained remarkably resilient. Major cancelations of client bookings only occurred in 2000 (approximately 40% of hunts were cancelled), and within three years the conservancy was once again running at capacity.

The revenue derived from hunting has been crucial in aiding and assisting neighbouring communities. BVC achieves this in a number of ways. 1.6 tonnes of meat are donated to the Maranda community every month and the community elected committee decide whether to sell the meat to raise funds for schools and clinics, or to divide it amongst themselves. After the establishment of the Mtetengwe trust, the conservancy has also financed the construction of a clinic and a number of essential boreholes in the surrounding communal lands. Schools are also frequently assisted, and it is likely that any action which impacts on the conservancy's ability to generate income through trophy hunting will have a knock on effect on the community's that are supported by the conservancy.

4. The introduction of black rhino

A brief note on the rhino population is relevant here for two main reasons. Firstly, it illustrates how areas utilised for trophy hunting can achieve meaningful conservation goals, and at times out perform formally protected areas. This is generally overlooked but it is relevant because it is largely financed from revenue gained from trophy hunting, including the hunting of lion and other species, though donor funds do partly offset the anti-poaching costs on BVC. Secondly it is important because it highlights the intensive anti-poaching efforts that have allowed the lion population to thrive.

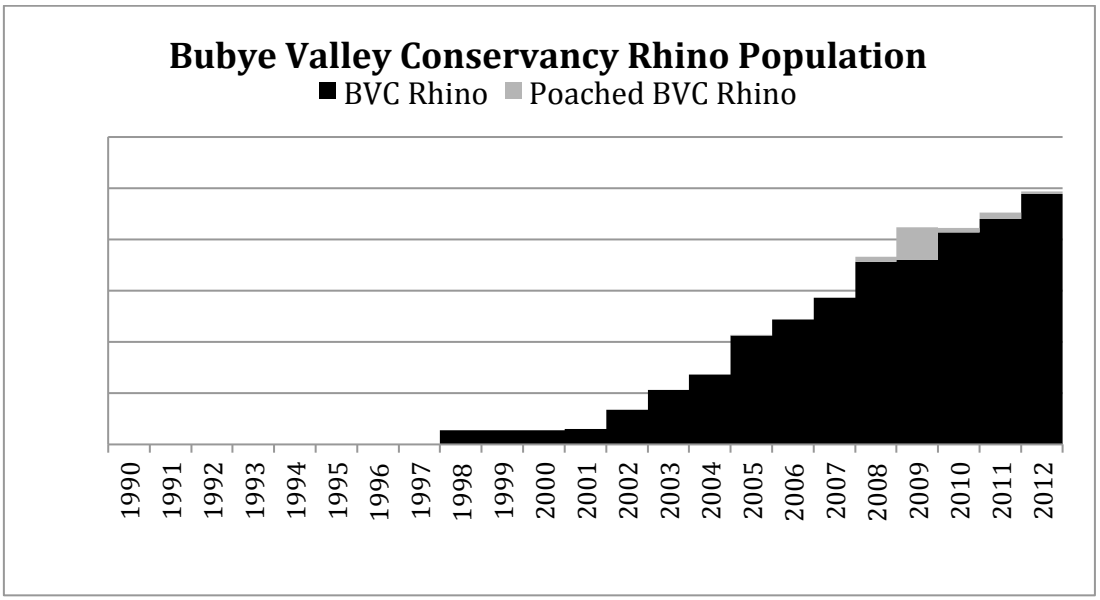


Figure 2. The establishment and growth of the combined black and white rhino population with poaching losses indicated. Actual numbers are not shown due to the sensitive nature of this information (Anderson 2012).

Black rhino were first introduced in 1998 (Anderson 2012). The population growth rate was accelerated by continual translocations from other areas that were not able to protect their rhino populations as poaching escalated in Zimbabwe and neighbouring South Africa during the mid 2000s (Figure 2). In the face of the renewed rhino-poaching onslaught in Zimbabwe, only the big privately owned conservancies were able to maintain positive rhino population growth rates (Figure 3). The most successful of these was BVC, which boasts the fifth largest black rhino population in the world (pers. com. Anderson 2012).

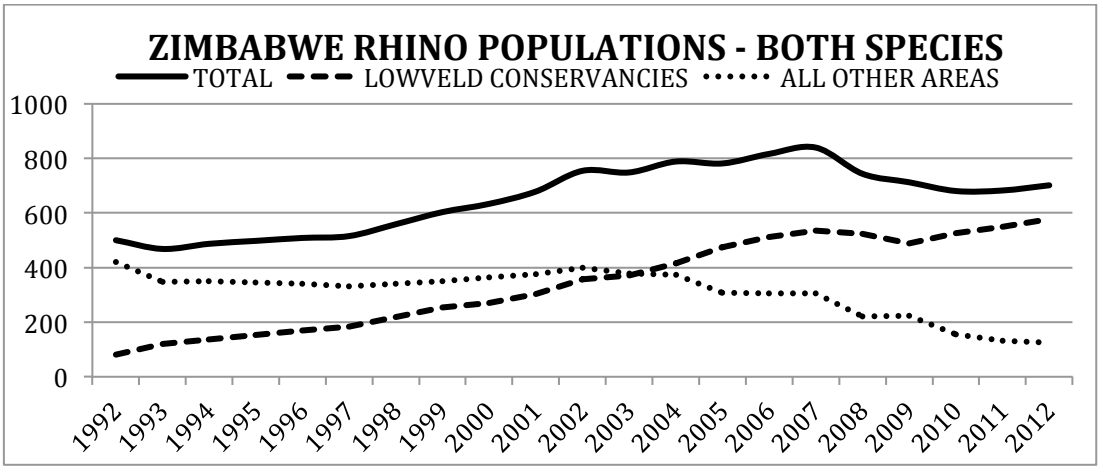


Figure 3. Shows the number of rhino in the lowveld conservancies and all other areas as well as the combined national population (Anderson 2012).

5. The lion population

5.1. Re-introductions and monitoring

In 1999, thirteen lions were re-introduced to the Samanyanga section of BVC, and in the same year four young males also entered naturally and were thought to have come from Gonarezhou National Park. Initially the lions were intensively monitored using radio collars and all individuals as well as births and deaths were known and recorded (Steyn 2001).

In 2002, following the collapse of the ecotourism venture on Samanyanga, the section was added onto the main conservancy and the partitioning fence was removed. Intensive lion monitoring ceased after 2002, but the management team made annual estimates of the lion population that were judged by experienced wildlife managers. In 2009 a lion and leopard research project was initiated, and annual spoor transects have since been conducted to estimate the lion and leopard population sizes and densities. A sufficient number of lions are now monitored using satellite collars in order for population estimates to be carried out by extrapolating from the number of known lions within the core study area. To date 18 lions have been collared on the conservancy, with each collar representing one female pride or male coalition (Figure 4).

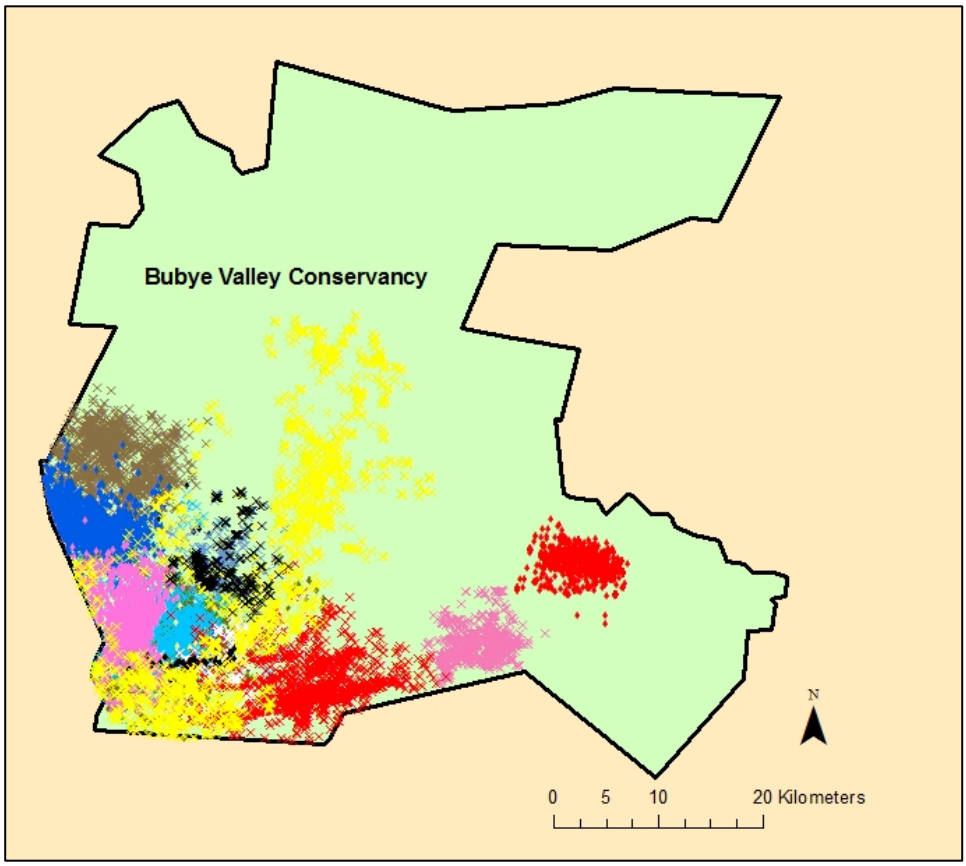


Figure 4. Shows lion collar data from BVC. Males represented by crosses, females by diamonds, individuals separated by colour

Following the removal of the Samanyanga fence, the lion population has grown exponentially. In 2009 when spoor transects were initiated, the total population was

estimated to be 116 at a density of 0.043km^{-2} and it has continued to grow. Today, just four years later there are estimated to be 332 lions (density 0.12km^{-2}) on BVC.

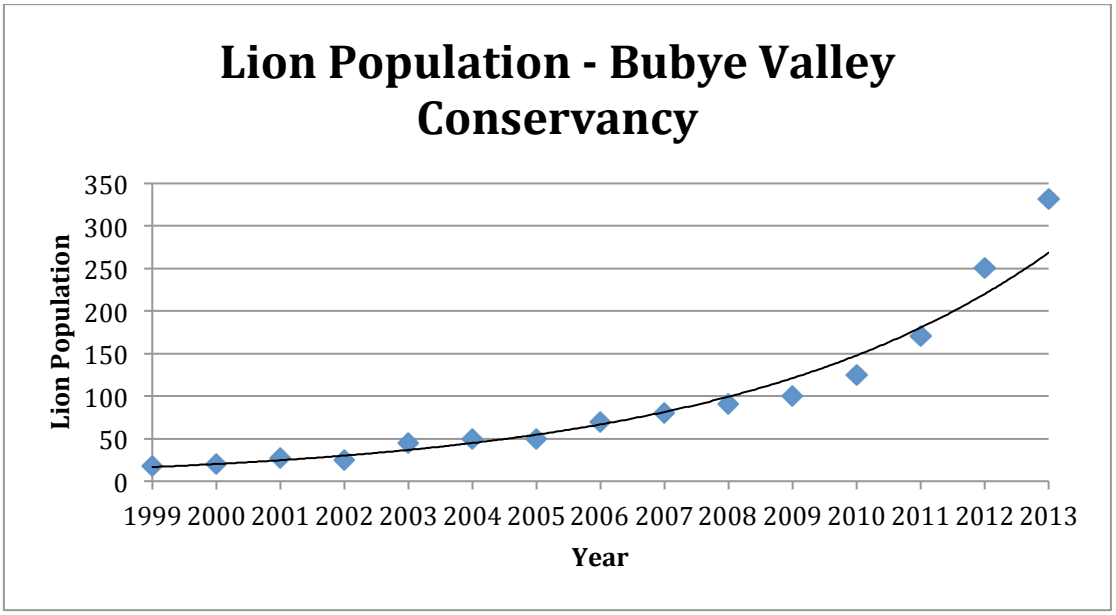


Figure 5. Shows the BVC lion population from the initial introduction to present. Population known to individual level 1999 – 2002, management estimates 2003 – 2008, spoor transects 2009 – 2012, current count by extrapolation 2013.

5.2. Trophy hunting of lions

Trophy hunting of lion began on BVC in 2002 when the first lion hunt was conducted. The quota was gradually increased as the lion population grew (Table 1), and hunt success rates over the last ten years have been 100%. Only one lion hunt has been unsuccessful in the ten years since lion hunting was initiated and the client reportedly opted not to shoot on a number of occasions when suitable males were seen, preferring to target one old male known to be limping (pers. com. Sharp 2008). Hunting success rates are recognised as an indication of population trends (Packer et al. 2010), suggesting that the BVC lion population is well managed. BVC also recorded the largest lion trophy taken in Zimbabwe for both the 2010 and 2012 hunting seasons, and narrowly missed the largest trophy for 2011, and this also indicates that the lions on BVC are being hunted from a healthy and abundant population.

Table 1. Issued quota and success rates per year in Bubye Valley Conservancy (2002 – 2012)

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Population est.	25	45	50	50	70	80	90	116	125	171	240
Quota issued	1	2	3	2	2	2	3	3	5	8	12
Actual off-take	1	2	3	2	2	2	2	3	5	8	12
Success rate (%)	100	100	100	100	100	100	66	100	100	100	100

Anthropogenic mortalities have periodically been incurred when lions have been caught in wire snares as part of bush-meat poaching. Lions make up an alarmingly high proportion of the animals that are caught in snares. The intensive anti-poaching efforts mean that bush-

meat poaching is not a significant problem on BVC, and only 20 animals (of all species) were recorded as caught and killed in wire snares in 2012. However, of these 20% (4) were mature lions. Figures are not available prior to 2012 but according to the management team it is not unusual for lions to be disproportionately caught in snares (pers. com Leathem 2012). This makes sense, as lions are especially susceptible to wire snaring (Becker et al. 2013). Wire snares in the area are generally set in lines of 20 to 40 snares along well-used game paths. Lions range widely and may be attracted to the sounds of distressed animals caught in snares or the smell rotting carcasses. Once in the vicinity the chance of being caught in snares increases exponentially.

The high level of protection awarded to African lions coupled with the moderate to high off take levels via trophy hunting serve to highlight how trophy hunting of lions can be easily sustainable, provided that poaching is controlled. This is also illustrated in a comparison between the BVC and SVC conservancies. Both BVC and SVC are found in the south-eastern lowveld of Zimbabwe and similar numbers of lions were introduced at similar times. Whilst SVC represents a remarkable lion conservation success story in its own right, the BVC lion population has grown more rapidly. This is likely to be because BVC has experienced less mortalities from wire snaring. BVC has managed to remain intact during the controversial land reform program (although land has been conceded, the main conservancy has always been securely fenced), whereas SVC had resettlement imposed on approximately 33% of the total area (Lindsey et al. 2008). This has resulted in a huge increase in illegal bush-meat poaching, with 84 396 wire snares being collected by anti-poaching personnel between 2001 and 2009 (Lindsey et al. 2011), and this may account for the different population growth rates of the respective lion populations.

5.3. Controlling the lion population

The BVC lion population may be approaching saturation point. Fenced lion populations frequently need to be controlled (Packer et al. *in press*), and there are increasing incidences of intraspecific mortalities. The population is already close to 100% of the conservancy's carry capacity as calculated following Hayward et al. (2007). There are concerns amongst the management team that this may cause a crash in the herbivore population as well as be detrimental to the mesopredator community, which includes certain rare and endangered species such as African wild dog (*Lycaonpictus*) and cheetah (*Acinonyxjubatus*), if the lion population continues to grow at the current rate. It is therefore highly likely that there will soon need to be a management intervention to limit or reduce the lion population on BVC.

Increasing the lion quota may be one way of controlling the population, though it is likely that this will need to be supplemented by either culling or translocations since even relatively high off take quotas (±2.5 lions/1000km^2 as opposed to the frequently recommended quota 0.5 lions/1000km^2 from Packer et al. 2010) have not had any apparent effect on the population growth rate. There are few areas capable of accepting lions at this point in time, limiting the potential for translocations. However, plans were in place to reintroduce lions to Majete Reserve in Malawi, and to boost the lion population in Gonarezhou by introducing prides from BVC free of charge. Unfortunately these plans were never carried out because of an overwhelming bureaucratic process and the necessary permits were never issued. The use of contraception to control the BVC lion population is not attractive to the shareholders or the management of the conservancy because it is likely to be time consuming, expensive, and difficult to carry out on a large scale.

6. Future scenarios

Intuitively, there are two likely scenarios for the lions of BVC. In the first, lion hunting is severely restricted either through a USFWS listing as endangered, or an upgrading to CITES Appendix I, making lion hunting for the current clientele undesirable or impossible. As a result the conservancy is forced to drastically reduce the lion population to remain financially viable. Due to the propensity of lions to breed (Smuts 1978) and the perceived (and real) cost of their predation on rare and valuable herbivore species, a decision may be made to eradicate them entirely in order to avoid repeated culling operations. If lions are tolerated it will likely be in low numbers and hunts may continue on a very small scale; willing clients and legal permits permitting.

In the second scenario, lion hunting is not restricted in any far reaching manner. The Zimbabwe Parks and Wildlife Management Authority remain in control of quota settings and based on their assessments, independent monitoring, and conservancy requests, reasonable annual hunting quotas are issued. Lions remain a financially valuable species and are therefore desirable in high numbers. The conservancy management not only tolerates a lion population that is at or close to the conservancy's carrying capacity, but also intervenes in the event that threats to the population are detected (be it diseased outbreaks or reduced viability due to genetic isolation, for example). In this scenario, trophy hunting is unlikely to be sufficient to control the population and a source population is available for restocking other areas.

7. Conclusion

Bubye Valley Conservancy represents one of the best examples of African conservation success in recent times, particularly for African lion and black rhino. There is now a large, viable population of lions occurring in an area that would otherwise be utilised for beef production via cattle ranching. The lions were introduced at the expense of the conservancy shareholders who attempted to utilise them in a non-consumptive manor. After an attempt at ecotourism failed the lions were utilised via trophy hunting in a sustainable and responsible fashion that has achieved some of the largest trophies and the highest success rate in the country. As a result of trophy hunting, BVC may come to sustain a lion population similar in size to that found in Zimbabwe's largest protected area, Hwange National Park, the flagship of the country. They are currently a valuable species on the conservancy and will persist there as long as they remain financially viable. A USFWS decision to list the sub species as endangered would result in a major reduction or the complete eradication of lion on BVC.

8. References

Agritex. (1984). Map, Natural Regions and Farming Areas, Zimbabwe.

Anderson, N. (2012). Zimbabwe Rhino Monitoring Coordinator.

Becker, M., R. McRobb, F. Watson, E. Droge, B. Kanyembo, J. Murdoch and C. Kakumbi (2013). Evaluating wire-snare poaching trends and the impacts of by-catch on elephants and large carnivores. *Biological Conservation* **158**: 26-36.

Hayward, M. W., J. O'Brien and G. I. H. Kerley (2007). Carrying capacity of large African predators: predictions and tests. *Biological Conservation* **139**(1): 219-229.

Leathem, K. (2012). Conservator and General Manager - Bubye Valley Conservancy. Section Manager, Lemco Ranch (1987-1994).

Lindsey, P., R. du Toit, A. Pole and S. Romanach (2008). Savé Valley Conservancy: a large scale African experiment in cooperative wildlife management. Evolution and innovation in wildlife conservation in southern Africa. London, Earthscan**:** 163-184.

Lindsey, P., S. Romanach, C. Tambling, K. Chartier and R. J. Groom (2011). Ecological and financial impacts of illegal bushmeat trade in Zimbabwe. *Oryx* **45**: 96-111.

Packer, C., H. Brink, B. M. Kissue, H. Maliti, H. Kushnir and T. Caro (2010). Effects of Trophy Hunting on Lion and Leopard Populations in Tanzania. *Conservation Biology*.

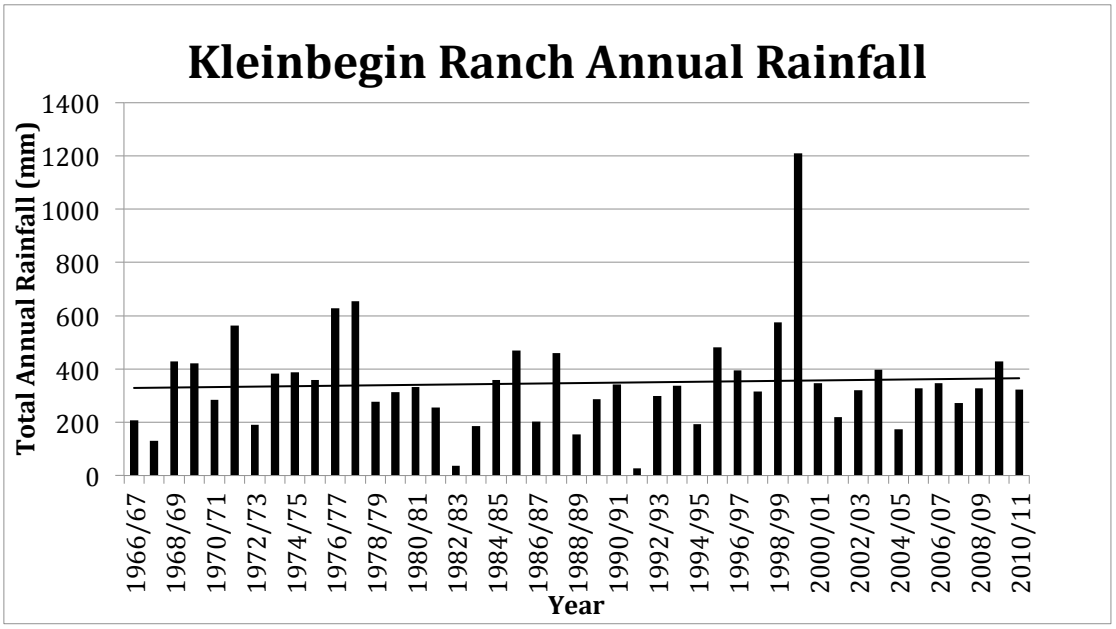
Packer, C., S. Canney, A. Loveridge, S.T. Garnett, M. Pfeifer, K.K. Zander, A. Swanson, D. MacNulty, G. Balme, H. Bauer, C.M. Begg, K.S. Begg, S. Bhalla, C. Bissett, T. Bodasing, H. Brink, A. Burger, A.C. Burton, T. Caro, B. Clegg, S. Dell, A. Delsink, T. Dickerson, S.M. Dloniak, D. Druce, L. Frank, P. Funston, N. Gichohi, R. Groom, C. Hanekom, B. Heath, L. Hunter, H.H. DeIongh, C.J. Joubert, S.M. Kasiki, B. Kissui, W. Knocker, B. Leathem, P.A. Lindsey, S.D. Maclennan, J.W. McNutt, S. Miller, S. Naylor, P. Nel, C. Ng'weno, K. Nicholls, J.O. Ogutu, E. Okot-Omoya, B.D. Patterson, A. Plumptre, J. Salerno, K. Skinner, R. Slotow, E.A. Sogbohossou, Stratford, C. Winterbach, H. Winterbach and S. Polasky (*in press*). Conserving Large Carnivores: Dollars and Fences. *Ecology Letters*.

Sharp, J. (2008). Professional Hunter, John Sharp Safaris.

Smuts, G. L. (1978). Effects of Population Reduction on Travels and Reproduction of Lions in Kruger-National-Park. *Carnivore* **1**(May): 61-72.

Steyn, L. (2001). Samayanga Lion Management Records.

Appendix 1.



Case study 2: Lion Hunting in Zimbabwe's Savé Valley Conservancy

1. Background

This document is a case study of the Savé Valley Conservancy in south-east Zimbabwe, where the African lion (*Panthera leo*) population is increasing exponentially, and where lions have been hunted since 2002. This case study clearly illustrates the positive conservation benefit that trophy hunting of lions can have for the species, and briefly describes the importance of hunting to maintaining wildlife in the area.

2. History of the Savé Valley Conservancy

The Savé Valley was a wildlife-rich wilderness until the early 1900s, when the first cattle ranching initiatives started in the area. The establishment of Devuli Ranch and Angus Ranch in 1920 paved the way for seven decades of commercial cattle ranching in the area we know today as the Savé Valley Conservancy. Roads were cut, fences erected and an everlasting "battle" ensued against the wildlife, especially against all predators.

After the Second World War, cattle prices soared to new heights, and the 1950s were years of development and expansion for the cattle industry. The large predators, especially lions, were virtually eradicated (Pole 1999). However, by the late 1980s, declining range productivity, depressions and droughts forced the landowners to consider alternative options. Around that time, empirical evidence of the competitive advantage of wildlife over livestock began to emerge (Child 1988; Bond 1993), especially in arid areas (Jansen et al 1992; Cumming 1993), and wildlife was finally given serious consideration as a viable land use option.

In 1989, a proposal was drawn up (du Toit 1989) to turn what was then the Sabi Valley Intensive Conservation Area into a wildlife conservancy. The plan was to create a single large wildlife area, especially for the re-establishment of endangered species and overexploited species, with cattle remaining the primary income generator. The Savé Valley Conservancy was constitutionally inaugurated in June 1991, and following the severe 1991/1992 drought, wildlife ranching became the primary land-use. At the time this was the largest private wildlife conservancy in the world (3,410 km^2).

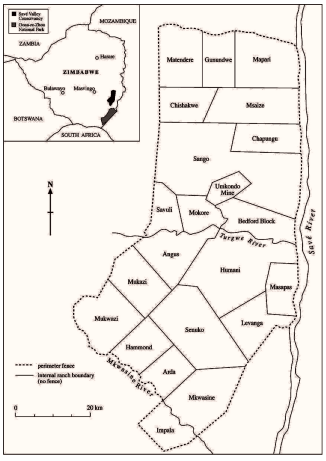


Figure 1 The Savé Valley Conservancy (taken from Lindsey et al 2008)

The conservancy members then restocked the wildlife population (4410 animals; Table 1), removed all internal fencing, erected a common perimeter fence and developed effective security systems. A double, electrified, veterinary-approved fence was completed in 1995, and the following decade saw a massive investment in wildlife re-stocking and security systems.

Table 1: Species and the number of animals per species re-introduced into the Savé Valley Conservancy, Zimbabwe

Animal Species	Number Of Animals Re-introduced				
	Prior to October 1993	November 1993 to December 1999	January 2000 to December 2002	January 2003 to present	**Total**
African buffalo (*Syncerus caffer*)	91	88	253	40	**472**
African elephant (*Loxodonta africana*)	685	-	-	-	**685**
Black rhinoceros (*Diceros bicornis*)	-	31	-	-	**31**
Blue wildebeest (*Connochaetes taurinus*)	223	525	49	-	**797**
Burchell's zebra (*Equus burchellii*)	17	309	66	-	**392**
Giraffe (*Giraffa camelopardalis*)	36	101	44	-	**181**
Lichtenstein's hartebeest (*Alcelaphus lichtensteinii*)	-	-	-	28	**28**
Livingston's eland (*Tragelaphus oryx*)	215	263	102	-	**580**
Nyala (*Tragelaphus angasii*)	22	43	11	26	**102**
Lion (*Panthera leo*)	**-**	**3**	**-**	**10**	**13**
Spotted hyena (*Crocuta crocuta*)	-	-	-	3	**3**
Ostrich (*Struthio camelis*)	-	-	71	-	**71**
Sable antelope (*Hippotragus niger*)	49	203	122	-	**374**
Tsessebe (*Damaliscus lunatus*)	-	97	-	-	**97**
Warthog (*Phacochoerus aethiopicus*)	-	207	-	-	**207**
Waterbuck (*Kobus ellipsiprymnus*)	177	66	82	32	**357**
White rhinoceros (*Cerathotherium simum*)	-	-	-	20	**20**
TOTAL					**4410**

3. Trophy hunting versus Photo tourism in the Savé Valley Conservancy

Trophy hunting was essential for the successful transition of the conservancy from cattle to wildlife. During the early years, wildlife densities were low, resulting in poor potential for ecotourism, and hunting generated the income needed to erect the fence, re-stock game, and improve security, especially because of the significant numbers of black rhino now found there. Gradually, some of the ranchers shifted more into ecotourism. One property, Senuko Ranch, completed a 16 bed up-market lodge with a view of marketing non-consumptive safaris, doing game drives and bush walks and specializing in rhino walks and African wild dog den visits. Lodge occupancy rose from 0% in 1996 to 62% by the end of 1999.

However, the Zimbabwean land reform program, which was initiated in February 2000, soon made a strong negative impression in the international community, and resulted in travel bans and warning from most of Zimbabwe's source markets. This, together with the political instability meant that the wildlife industry and ecotourism industry collapsed over-night. Sport hunting and trophy hunting became the only economically viable land use options and have remained the only tangible source of income to the landowners of the SVC. In the case of the Senuko Lodge, for example, the land reform program resulted in a 98% cancelation of the confirmed bookings. After four years of seeking alternative markets, the lodge could achieve no higher than 17% occupancy, and in 2005 moved into a hunting-based operation.

A more direct impact of the land reform program for the Savé Valley Conservancy was the loss of 33% of the area of the conservancy to invading subsistence farmers (Lindsey et al 2008). The loss of land was catastrophic and the related pressure from wire snare poaching was extreme. In the following eight years (2001 to 2009), 10,520 illegal hunting incidences were recorded, 84,396 wire snares were removed and at least 6,454 wild animals killed (Lindsey et al. 2011).

4. Lions in the Savé Valley Conservancy

After the conservancy was formed, and persecution stopped, lions, mainly males, recolonized the area and their numbers started to increase in the late 1990s / early 2000s. Few lionesses were observed until 2003, when small family groups and male-female pairs were seen, and by 2004-5 there were some reports of cubs. During this period 13 lions were also reintroduced into SVC. After an initial lag phase the lion population on SVC has increased dramatically and at present is growing exponentially (Figure 1, Groom 2012).

In 1993, three lions were brought into the conservancy by Humani Ranch; two adult females and one adult male. One of the females was pregnant and four cubs were reared successfully. A further ten lions (four lionesses and six small cubs) were brought in in 2005 and released on Sango Ranch. A few months later three were killed by wire snares, and the rest of the group split up. Tracks suggest that three adult females and one cub survived.

4.1. Lion monitoring

Monitoring of the lion population began in 1999 (Pole 1999) with track index or call-up surveys being conducted sporadically until 2006. From 2007 to present, annual conservancy-wide track index surveys have been conducted using a standardized methodology (Groom 2012). The resulting population estimates were verified in 2011 by a baited lion call-up survey and a collation of managers' estimates, all of which provided similar results.

Prey availability models (Hayward et al. 2007) suggest that the lion population is currently only at 60% of ecological carrying capacity, and thus we can expect to see the upward trend continue unless population control measures are implemented.

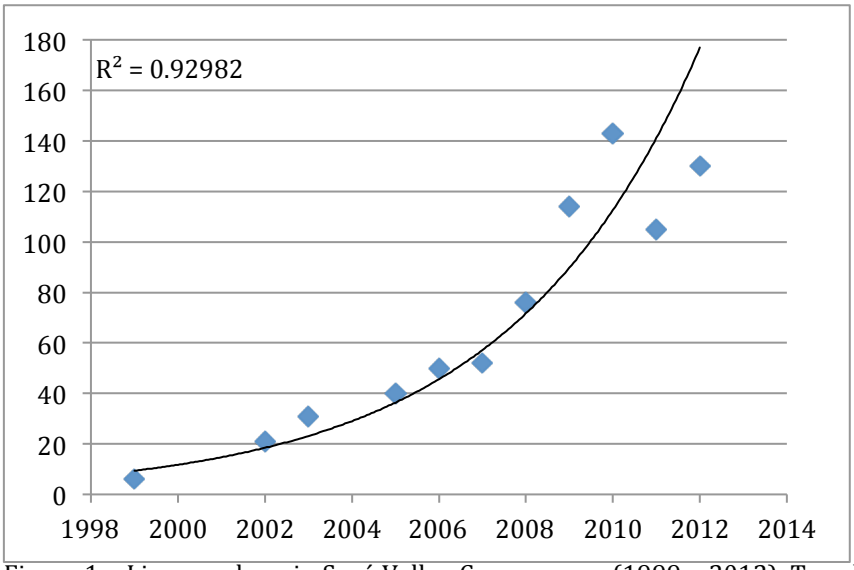


Figure 1 – Lion numbers in Savé Valley Conservancy (1999 – 2012). Trendline is an exponential growth curve. (Adapted from Groom (2012))

4.2. Lion management plan

A professional lion management plan was commissioned by the conservancy in 2011 (Funston 2011), to provide the SVC members with a science-based plan to help them ethically and sustainably manage their lion population. This plan specifically advocates the use of hunting as a conservation management tool. It demonstrates willingness by the conservancy to guide their lion management based on science and advice from professionals.

4.3 Lion hunting in the Savé Valley Conservancy

Lions have been hunted in Savé Valley Conservancy since 2002, although that was largely for removal of problem animals. Hunting began properly in 2005 with quotas increasing annually to a maximum of seven per year from 2009 onwards (Table 2), but with offtake never exceeding six.

T able 2. Lion quotas and offtakes in Savé Valley Conservancy from 2001 to 2011

Approved quota and success (offtake)	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Approved quota	4	5	5	1	3	3	4	6	7	7	7
Quota taken (Success)	0	1	0	1	3	3	3	3	6	5	3
Percentage success	0%	20%	0%	100%	100%	100%	75%	50%	86%	71%	43%

Despite offtakes of lions through trophy hunting, the lion population has continued to increase in the conservancy. This is largely because the lion population is still building up after the initial persecution, and trophy hunting of select, older males does not impact this growth. The revenue generated from hunting lions has enabled landowners to invest in proper land management, anti-poaching and fence maintenance, all of which benefit the lion population (especially as lions seem to be vulnerable to being caught in wire snares; Becker et al 2013; pers. obs.).

Trophy hunting of lions brings considerable revenue to the conservancy, revenue that is vital for the continued functioning of the area for wildlife conservation. A 21 day lion hunt is sold for c. $2,500 per day (prices vary slightly depending on the operator), with an additional trophy fee of $10,000. Net income from lion hunting from 2005 to 2011 (N = 26 lions) would therefore have amounted to c. US $1,365,000 in bed nights and $260,000 in trophy fees.

5. The impact of listing lions as endangered on the US Endangered Species Act

In the current political climate, landowners in the Savé Valley Conservancy have no alternative way to generate sufficient income from wildlife, other than from hunting. Lions are one of the most valuable species to the conservancy. If lions are upgraded to endangered on the Endangered Species Act in the US, the resulting ban on lion trophy imports into the US will effectively result in a collapse of the lion hunting industry in the Savé Valley Conservancy, where on average 90% of hunting clients are American (up to 98% for some properties; SVC members, pers. comm.). The loss of the c. $375,000 annual revenue will be catastrophic for the conservancy, inevitably resulting in less investment in security and other conservation measures.

It should be noted that lions impose a significant cost on conservancy landowners through predation on valuable prey species that could otherwise be sold as trophies or meat. For the Savé Valley Conservancy, this was calculated as a loss of US$ 494,776 in 2009, an 8% loss relative to gross income from the species when hunted at current levels (Funston et al, unpublished data). Without these costs being offset by the income from lion hunting, landowners cannot reasonably be expected to tolerate such high lion numbers, and lion numbers would have to be reduced significantly.

In the Savé Valley Conservancy therefore – and it is by no means the only area in this situation – the listing of lions as endangered on the US Endangered Species Act, and the subsequent collapse of the US lion hunting market, would necessitate a culling or contraceptive program for lions, in order to decrease their numbers to economically and ecologically tolerable levels. The upgrade would therefore, instead of protecting lions in these areas, effectively sign their death warrant.

The Savé Valley Conservancy is extremely expensive to run due to pressure from the illegal bushmeat trade and from rhino poaching. In recent years, robust earnings from trophy hunting have allowed annual investments of US$ 150,000 – 240,000 per year in ranch-based anti-poaching, ensuring that wildlife populations remained stable in all but the areas that were settled (and the heavily impacted immediately adjacent sections). In addition, a central anti-poaching unit operates specifically to provide protection for the conservancy's black rhino, *Diceros bicornis,* population (one of only three remaining populations in Zimbabwe that is defined as having long-term viability in demographic and genetic terms). The operating costs of this unit amount to over $200,000 per year and are shared between the conservancy members and donors. As rhinos are not trophy hunted in Zimbabwe, members' share of these costs need to be generated some other way – and lion hunting is an important contributor. Thus a removal of lions from the hunting quota due to collapsed demand would reduce the ability of the Savé Valley Conservancy to protect the wildlife resource, including endangered species like its valuable populations of African wild dogs, *Lycaon pictus*, and especially black rhinos.

A knock-on impact of this listing will be felt in the communities that neighbour the Savé Valley Conservancy. In 2012, conservancy members provided over US$100,000 worth of support to adjacent villages or farmers in the resettled areas. Assistance included drilling boreholes, maintaining boreholes, dredging of dams, assisting with building projects in clinics and schools, assisting with repairs, maintenance and materials at schools, education initiatives, school field trips, provision of computer equipment in schools, craft programs and regular donations of meat.

Moreover, the conservancy recently entered into a mutually dependent agreement with the Chiefs representing the communities surrounding the Savé Valley Conservancy. The agreement links the communities to the Natural Resource Utilisation that occurs through the business operation of the conservancy and opens up opportunities for the local indigenous populations to share in any wealth creation. This agreement strengthens relations between the conservancy and the surrounding local communities and creates an environment that helps to protect, conserve and sustain the natural assets of the area. The hunting tourism of the conservancy is currently the only form of income by which the surrounding communities can benefit. Revenues from trophy lion hunting constitute a significant portion of inflow and thus an important part of the community benefits. Any reduction would seriously jeopardise the growth of this infant positive relationship and community empowerment initiative.

The Savé Valley Conservancy is thus pioneering private-community partnerships in Zimbabwe, and trade restrictions on lion trophies will indirectly adversely affect these already seriously impoverished communities through a reduction in available income to share with communities. This is very likely to have a knock on impact on the lions themselves with a significantly reduced tolerance and an increase in retaliatory poisoning of lions for livestock predation. Without a demonstration of income from lions, the political pressure from the surrounding communities to remove them from the conservancy altogether will be a challenge to resist.

6. Conclusion

The Savé Valley Conservancy is an excellent example of a focussed and determined effort to make a wildlife based land use viable in an otherwise cattle dominated landscape. From inception, conservancy members and international investors have invested huge amounts of finance and effort into re-stocking the area, building up the wildlife to the incredible numbers and diversity found in the conservancy today, and protecting it from poachers. The revenue to do this has been almost exclusively generated through hunting, due to the collapse of the ecotourism industry after 2000.

In recent years, lion hunts have provided a significant financial contribution to the ever-more-expensive operation of the conservancy, enabling significant investment in security and community support and engagement. Should lions become listed as endangered on the US Endangered Species Act, the resulting collapse of the lion hunting industry will have serious negative implications. The cost of having lions, both ecologically and financially is high, and with no generation of revenue from the species, numbers will inevitably have to be curtailed.

7. References

Becker, M., McRobb, R., Watson, F., Droge, E., Kanyembo, B., Murdoch, J. & Kakumbi, C. (2013). Evaluating wire-snare poaching trends and the impacts of by-catch on elephants and large carnivores. Biological Conservation **158**, 26-36.

Bond, I. (1993) The economics of wildlife and landuse in Zimbabwe: An examination of current knowledge and issues. WWF Multispecies Project Paper No 36, Worldwide Fund for Nature, Harare, Zimbabwe

Child, B (1988) The role of wildlife utilization in the sustainable economic development of semi-arid rangelands in Zimbabwe. DPhil Thesis, University of Oxford, Oxford, UK

Cumming, D.H.M (1993) Multi-species systems: Progress, prospects and challenges in sustaining range animal production and biodiversity in East and southern Africa. In Proceedings VII World Conference on Animal Production, Edmonton, Alberta, Canada

Funston, P.J. (2011) The Savé Valley Conservancy Lion Management Plan, 2011. Report for the Savé Valley Conservancy

Groom, R.J. (2012) Carnivore densities in the Savé Valley Conservancy: 2012. Report for the Savé Valley Conservancy

Hayward, M.W., O'brein, J. & Kerley, G.I.H. (2007) Carrying capacity of large African predators: predictions and tests. Biological Conservation, **139**, 219-229

Jansen, D.J., Child, B. & Bond, I. (1992) Cattle, wildlife, both or neither: Results of a financial and economic survey of commercial ranches in southern Zimbabwe. WWF Multispecies Project Paper No 27, Worldwide Fund for Nature, Harare, Zimbabwe

Lindsey, P., du Toit, R., Pole, A. & Romanach, S. (2008) Savé Valley Conservancy: a large scale African experiment in cooperative wildlife management. Chapter 11, pages 163-184 in B. Child, H. Suich and A. Spenceley, "Evolution and innovation in wildlife conservation in southern Africa." Earthscan, London.

Lindsey, P., Romanach, S., Tambling, C., Chartier, K. & Groom, R.J. (2011) Ecological and financial impacts of illegal bushmeat trade in Zimbabwe. Oryx, **45**, 96-111

Pole, A. (1999) The behaviour and ecology of African wild dogs, *Lycaon pictus*, in an environment with reduced competitor density. PhD thesis, University of Aberdeen, Aberdeen, Scotland

du Toit, R. (1989) Proposal for Savé Valley Conservancy. Unpublished report for the Intensive Conservation Areas Committee, October 1989, Harare, Zimbabwe

du Toit, R. (1994) The Savé Valley Conservancy. In: The Lowveld Conservancies: New opportunities for productive and sustainable land use, pp. 28-36: Price Waterhouse Wildlife, Tourism and Environmental Consulting, Zimbabwe