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The Impacts of African Elephant (*Loxodonta africana*) on Biodiversity within Protected Areas of Africa and a Review of Management Options

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Introduction

The story of the protection and conservation of the African elephant (*Loxodonta africana)* is widely regarded as an astounding success as parks and reserves all over Africa report explosive elephant population growth (Lombard et al., 2001; Loarie et al., 2009; Smit, et al., 2010). Being placed in the CITES Appendix I in 1989 (Kalwij et al., 2010), the enactment of the African Elephant Conservation Act of 1988, and the establishment of the African Elephant Program by the World Wildlife Fund in 2000 (Stephenson et al., 2010) have contributed greatly to the recovery of the African elephant population after poaching and the ivory trade critically threatened the species' survival. Species listed in CITES Appendix I are those that are threatened with extinction and so the trade involving these animals is greatly restricted and closely monitored. The African Elephant Conservation Act prohibited the export of raw ivory and further restricts the ivory trade. The objectives of the African Elephant Program are to improve protection and management of elephant populations, to aid range states with the conservation and management of their elephant populations, increase public support for the conservation of elephants, and to assist in the control of ivory trade. These protective measured have helped raise awareness for this threatened species and has put a ban on the trade of ivory or other elephant products has been an incredibly successful conservation strategy. Data from the World Wildlife Fund website, states that the species is now considered vulnerable and there are elephant populations in 37 countries, known as range states, across Africa (2013).

As African elephant numbers continue to rise, ecologists and wildlife managers must adapt management strategies to allow optimal protection for this vulnerable species while

maintaining biodiversity within protected areas (Kalwij et al., 2010).   The African elephant has a large impact on their surroundings and acts as the predominant ecosystem engineer in these protected areas (Lombard et al., 2001; Nasseri et al., 2010; Valeix et al., 2011). A fully grown elephant can consume up to 180 kg (wet weight) per day (Kerley et al.. 2006). Since elephants employ strategies such as bark stripping, breaking major branches, and uprooting trees and shrubs when browsing (Nasseri et al., 2010; Valeix et al., 2011), there is concern that at high densities elephants will negatively affect plant community structure, function, and species richness (Lombard et al., 2001; Young et al., 2009). In addition to the destructive nature of their behavior, elephants are quite selective and wastefully when browsing (Landman et al., 2007; Boundja & Midgley 2009; Loarie et al., 2009) and will uproot trees and pull down entire branches to reach a few choice leaves. These tendencies add to the risk of local extinction of elephant's preferred plants, whose protection park managers must balance with those of the threatening herbivores (Palmer et al., 2003; Landman et al., 2007; Valeix et al., 2011). There is strong concern that left unchecked, elevated elephant populations will convert their habitats from dense woodlands to sparse shrub or even grassland areas, a change that will have far-reaching impacts to other plants and animals also dwelling in these areas.

There are several options being considered by park manager to prevent or reverse the negative impacts of elephant population growth including; culling, immunocontraception, translocation, artificial waterhole installation, and habitat expansion (Fayrer-Hosken et al., 2000; Pimm & van Aarde, 2001; Owen-Smith et al., 2006; Freeman et al., 2008; Mackey et al, 2009; Smit & Ferreira, 2010). Culling, translocation, and artificial waterhole creation are methods that have been used in the past and offer only a temporary solution. Although providing individuals with contraception and allowing the enlargement of elephant habitats would provide a more

permanent management solution, they are not always practical due to lack of funding, research, and available land (Pimm & van Aarde, 2000; Lombard et al., 2001; van Aarde & Jackson, 2006; Mackey et al., 2009; Shannon et al., 2009). This issue is becoming increasingly controversial due to the popularity of the elephant to tourists, who provide much of the funding of these protected areas.

Causes of Overpopulation

Fences have been erected in protected areas to reduce human-wildlife conflict (van Aarde & Jackson, 2006; Loarie et al., 2009; Smit & Ferreira, 2010; Vanak et al., 2010). They allow poaching to be more easily monitored, protect livestock from wild predators, and increase the chances of desired wildlife sighting by visiting tourists that provide funding to these areas (Lombard et al., 2001; Smit & Ferreira, 2010). Because fencing limits the movement of elephant herds, they can cause elephants and other herbivores to become sedentary (Brits et al., 2002) and exaggerate effects on vegetation which homogenizes impacts within the fenced-in areas (Smit & Ferreira, 2010, Vanak et al., 2010). It is believed that wild elephants have home ranges that can exceed 1.7 million km^2 (van Aarde & Jackson, 2007), which is much smaller than documented home ranges in protected areas (Shannon et al., 2005) due to habitat fragmentation by fence lines and human presence. In Kruger, cow herds have a home range averaging around 240 km^2, in Addo Elephant National Park the home range is recorded to be 52.8 km^2, and 99.7 km^2 in Pilanesberg National Park (Shannon et al., 2005). These drastically reduced home ranges cause pressure on the surrounding area by elephant presence to be exaggerated and have resounding effects on the plant and animals communities.

In the absence of these fences, elephant herds would move across the continent following the rain, allowing them to have continued access to water (Loarie et al., 2008). This would give landscapes a reprieve from elephant presence and time to recover from the damage done by the elephants during the wet season, limiting the lasting effects (Loarie et al., 2008). In this manner, fences force elephants to utilize the same areas year-round and so instead of recovering, landscapes continue to be browsed, grazed, and trampled (Loarie et al., 2008). Since fences create a border of the elephants' home range, herds tend to visit areas along fence lines more often than areas toward the center of their home range, causing more elephant trampling in certain areas (Vanak et al., 2010). In Pilanesberg National Park, South Africa, it was seen that elephants avoided browsing along the boundaries of their range, near the fence lines, which created more browsing pressure in the interior of the park instead of spreading the effects out along the entirety of the herd's home range (Vanak et al., 2010). Although fences have made the recovery of the African elephant population possible, in times of high elephant density, they can have undesirable effects on the behavior of elephant herds.

Park managers can also install artificial water supplies to provide year-round water access to elephant herds in many parts of protected areas (Smit & Ferreira, 2010) relieving some negative effects of prolonged droughts (Brits et al., 2002). This alleviates some of the stress caused to elephant herds by fencelines that prohibit them from travelling across the continent to constantly remain in areas experiencing the rainy season (Brits et al., 2002). Areas near water-holes tend to be visited more often than other areas within home ranges which add stress to vegetation near water-holes, called sacrifice areas, because of additional trampling and grazing (Brits et al., 2002). These water-holes can cause populations to expand their distributions, decrease their individual home ranges, revisit patches within home ranges more often, , and

increase their densities (Smit et al., 2010). The most prominent effect in the woody vegetation in sacrifice areas was a reduction in shrub density in the first 2800 m (Brits et al., 2002) causing habitat degradation and loss of biodiversity in many fragile habitats because of the added traffic in these areas as herds' dependency on these water sources grow (Shannon et al., 2009).

It has been suggested that when artificial waterholes are utilized, there should be many small grouped water supplies separated by large waterless areas, mimicking elephants natural tendency to travel migrate following the rains, so that elephant habitat diversity can be maintained and trampling around the watering points will be minimized (Thrash, 2000; Shannon et al., 2009). Modeling has shown that reducing the amount of permanent water supplies could reduce the amount of land that contains paths formed by elephant tampling by up to 80% (Shannon et al., 2009). Artificially placed water-holes are often necessary to counteract the negative effects that fence lines have on elephant herds but without proper planning, can cause an equal number of problems.

Effects of Elephants on Woody Vegetation

Elephants have the ability to convert forests and intact woodlands into mixed woodlands or grasslands due to the vast amounts of food they consume daily, and their feeding behaviors (Guldemond & van Aarde 2007; Nasseri et al., 2010). This can change the composition and structure of plant communities and may impact competitive interactions between plants and other animals dependent upon these plants (Landman et al., 2008). Elephants, like most herbivores, are more likely to feed on tree species that are rich in nutrients, increasing the risk of damage to their preferred food sources (Boundja & Midgley, 2009). In areas with browsing elephant herds, there are expected differences in density, species number, turnover, and composition of woody

vegetation (Lombard et al., 2001; Brits et al., 2002; Guldemond & van Aarde, 2007; Asner et al., 2009). The loss of woodland has been well-documented in the past 50 years which is largely attributed to the rising elephant population in small, fragmented protected areas (Western & Maitumo, 2004). The reduced biodiversity seen in woodland species has a strong affect on other taxa in the area and so has become a major focus of conservationists (Western & Maitumo, 2004).

Many protected areas in southern and eastern Africa have observed local extinction of some tree species (Boundja & Midgley, 2009). This is due to the manner in which elephants browse, by pulling down tall, desirable branches, uprooting shrubs and small trees, and . Elephants show preference for certain plants; many *Acacia sp, Aloes, Colophospermum mopane, Spirostachys africana, Commiphora merkerii* (O'Connor et al., 2007; Boundja & Midgley, 2009; Parker & Bernard, 2009) which leads to an increased abundance of woody plant species that are not selected by herbivore populations (Scogings et al., 2012). Only 30% of woody plants common in Chobe National Park, Botswana were found to be moderately or highly acceptable to elephants in the wet season and 50% in the hot, dry season (Owen-Smith & Chafota, 2012). While these patterns are widely observed, high densities of elephants are not always associated with reduced woody cover and each case should be considered separately (Valeix et al., 2011). Elephants have also been seen to halt recruitment in heavily impacted areas (Owen-Smith et al., 2006). Some species that are heavily selected by elephants have evolved faster regeneration and are better able to deal with elephant damage, such as many acacia species (O'Connor et al., 2007). One option being considered by managers is to allow the local extinction of some plant species within protected areas but to insure their survival on a regional scale by maintaining areas that negatively impact them less (O'Connor, 2007). A long-term exclusion study in Kruger

National Park showed that after 6 years there was a greater herbaceous cover but very little change in the 3-D structure of the landscape (Asner et al., 2009). After 22 years there was an increase in woody canopy cover and 3-D structural diversity seen in upland and lowland areas (Asner et al., 2009). Several long-term studies conducted in Amboseli National Park on the restoration of woodlands showed that elephants are the only factor present that prevents full restoration of the woodland environment (Western & Maitumo, 2004).

Plants that are especially vulnerable to elephant browsing, referred to as Important Plants, are typically small succulent shrubs and geophytes (Landman et al., 2008). Fecal analysis has shown that of the 90 plant species that makeup the diet of elephants in Addo Elephant National Park, South Africa, 14 of the 77 Important Plants were present (Landman et al., 2008). This shows that elephant browsing is an important mechanic of Important Plant decline, but is not the only factor. Elephants browse on greener than average plants throughout the year, determined by their Enhanced Vegetation Index (EVI) (Loarie et al., 2008). Since this pattern continues even when they are constrained by seasonally available water, this shows that elephants need heterogeneous landscapes to access different types of vegetation in different seasons (Loarie et al., 2008).

Elephants are important seed dispersers for many forest and savannah tree species (Boundja & Midgley, 2009). Since elephants can travel more than 8 km per day, they allow seeds of their preferred trees to move to areas not reached by other methods of dispersal by birds, wind, or other grazers with smaller ranges. This helps to maintain woodland structure and prevent bush encroachment (Boundja & Midgley, 2009).

Effects of Elephants on Other Animals

The effect that elephants have on other animals is not always clear or consistent between areas. Typically a decrease in non-elephant density accompanies rising elephant densities (Valeix et al., 2011) As elephants change the structure of the landscape, they can modify the amount of visibility in an area (correlated with predation risk) and create new environments for invertebrates, reptiles, and amphibians (Landman et al., 2008; Valeix et al., 2011). Higher species richness of spiders has been observed in areas of high elephant damage (Nasseri et al., 2010). They also allow some herbivores to encounter plants that would not otherwise be accessible to them (Landman et al., 2008).

Tortoises browse selectively on geophytes and succulents and benefit from the broken branches left on the ground by elephants (Landman et al., 2008). A study performed in Endarakwal Ranch, Tanzania showed that areas of high elephant damage also had a higher species richness of herpetofauna due to the creation of complex habitats (Nasseri et al., 2010). These habitats tend to include coarse woody debris that can be used as hunting areas, refuges, and breeding grounds (Nasseri et al., 2010). Frogs species richness nearly doubled in areas of high damage (Nasseri et al., 2010). In Mpala Research Centre, Kenya, it was seen that an aboreal gecko, *Lygodactylus keniensis* was dependent on elephant-damaged trees as refuges that their local density is most regulated by the amount of elephants in an area (Pringle, 2008). Elephant damage creates holes in the canopy which allows an increase of light intensity, a habitat desirable to many species of butterflies (Bonnington et al., 2007). In western Tanzania, it was seen that more butterflies are present in areas of high elephant damage, especially in the sub-family Nymphalinae and the family Satyridae (Bonnington et al., 2007).

A study in Hwange National Park, Zimbabwe showed that steenbok and impala prefer to graze in areas that show elephant damage (Valeix et al., 2011). Impala and kudu show a

preference for plants with accumulated elephant damage except for *Capparis tomentosa* (Makhabu et al., 2006). Giraffe and kudu select sites that include plants that have been broken or uprooted by elephants, but tend to avoid areas that include trees and shrubs that have been coppiced by elephants, but only in heavily wooded areas (Makhabu et al., 2006; Valeix et al., 2011). It is believed that this distinction is made because in less densely wooded areas, the higher level of visibility increases the predation risk of these herbivores (Valeix et al., 2008). Elephant damage seemed to have no influence on the behavior of zebra (Makhabu et al., 2006; Valeix et al., 2008). This study was conducted in the dry season and so caution should be taken when drawing conclusions from these results. These findings are consistent with a study in Chobe National Park, Botswana that showed a positive correlation between the spatial distribution of small herbivores and the amount of elephant modification in an area (Valeix et al., 2011). The African buffalo has also shown a preference for grazing in areas that have had recent (within 3 to 10 days) elephant damage (Makhabu et al., 2006).

The reductions of canopy cover by mega herbivores, including elephants, have a negative impact on species richness of woodland birds (Ogada et al., 2008). In Mpala Research Center, Kenya, it was seen that the presence of areas with native herbivores bird species richness and diversity was reduced by 30%, but overall bird abundance was not affected (Ogada et al., 2008). This is believed to be because of the reduction of available perching locations and protection from aerial predators (Ogada et al., 2008).

Evaluation of Culling as Elephant Population Management

Culling is undoubtedly the most effective method of reducing elephant populations but is incredibly controversial (Pimm & van Aarde, 2001). When performing a cull, if managers are

not carefully with the selection of individuals to be culled, age structures may be drastically changed and may not actually slow the growth rate (van Aarde & Jackson, 2007). The selection of entire herds reduces emotional trauma to the surviving elephants and keeps the structure of remaining herds intact. This method would overshadow the effects of natural selection and may allow undesirable genes to persist while removing desirable genes from the pool. Often, the meat and tusks of the culled elephants are sold and generate revenue for the park. This method of population management circumvents the rules of natural selection, however, and there is no way of knowing whether desirable or undesirable genes are being removed from the pool, which in the long-term may reduce the fitness of the entire species within protected areas.

Culling has been implemented in Kruger National Park since 1967 to limit the population to around 7,000 individuals but a moratorium was placed on the practice in 1994 while the method underwent evaluation (Owen-Smith, 2006). While culling did effectively reduce the number of elephants within the park, there was a large increase in the growth rate immediately following the cull (van Aarde & Jackson, 2007). After the conclusion of the Elephant Science Roundtable in 2006, the Minister of Environmental Affairs and Tourism stated that he saw no evidence that necessitated the large-scale reduction of the elephant population in Kruger but that in protected areas, such as Kruger, elephant density, distribution, and structure may need to be managed on the local level to promote biodiversity (Owen-Smith et al., 2006).

A major source of conflict with culling comes from tourists. Elephants are one of the animals that are most desired to see by visitors to protected areas and without high densities of elephants, it is not always possible for tourists to see the amount of elephants that they expected when paying for the game drive. Due to the love tourists have for elephants, parks that implement culls tend to receive negative backlash from the public and may lose visitors which

provide a major source of income for these protected areas. For these reasons, many parks try to find other solutions to overpopulation when possible.

Evaluation of Contraception of Elephant Population Management

Immunocontraption is less controversial than culling and is the only other method that can be immediately implemented, but little is known about the long-term effects on treated elephants (Mackey et al., 2009). One type of immunocontraption that is available is porcine zona pellucid (pZP) vaccine which stimulates an individual's immune system and prevents sperm from penetrating the egg (Mackey et al., 2009). Modeling has shown that the contraception of 75% of breeding-aged females for 20 years could reduce the annual growth rate by 50% (Mackey et al., 2009). Slight fluctuations are expected in these numbers depending on the age structure of the target population, large, well-established populations should have a higher mortality rate than populations with a younger population structure (Mackey et al., 2009).

Modeling has shown that to use immunocontraption to control the population of elephants in Kruger National Park, South Africa, it would be necessary to treat 2,250 cows each year for 11 years (van Aarde & Jackson, 2007; Pimm & van Aarde, 2011). Using the current cost of this treatment and assuming it was 100% effective, the cost of this would be greater than the total management budget for the South African national parks during this time (Pimm & van Aarde, 2011).

Criticisms of using contraception includes the side effects observed by treated individuals, the elimination of natural selection, and changes in herd structure and behavior (van Aarde & Jackson, 2007). Often, hormonally treated cows remain in heat longer than usual and experience additional harassment by bulls (van Aarde & Jackson, 2007). The reduction of birth

rates alters the age and social structure within elephant herds and may affect the well-being of cows and their calves (van Aarde & Jackson, 2007).

Evaluation of Translocation of Elephants on Population Management

Translocation is good for encouraging gene flow and maintaining diversity in the elephant population (van Aarde & Jackson, 2007). Translocation is not a feasible method for controlling large elephant populations because it can be difficult, expensive, and traumatic for translocated individuals, and there is a lack of protected areas that can support extra elephants (van Aarde & Jackson, 2007). The disruption of the social structure of a herd can cause behavioral changes in the reintroduced individual as well as the individuals left behind (van Aarde & Jackson, 2007). Since most protected areas are experiencing an overpopulation of elephants, it can be difficult to find an area willing to bring in more individuals (van Aarde & Jackson, 2007).

Evaluation of Megapark Creation on Population Management

It is possible that the dropping of fence lines between parks to create larger sections of protected areas would create a more balanced ecosystem. This would allow elephant herds to occupy larger home ranges, follow the seasons, and allow a more natural limitation of their population and resulting impacts (van Aarde et al., 2006). Creating a more heterogeneous spatial template would reduce the need for continual population management (Owen-Smith et al., 2006). In 2004, the fences were dropped between Phinda Private Game Reserve and two neighboring reserves in South Africa (Druce et al., 2008). Observation of the elephant populations within these parks showed that at first individuals were cautious when entering their newly expanded territory (Druce et al., 2008). Older bulls that had been only recently moved to the park were the

first to enter the new additions to the park (Druce et al., 2008). Young bulls that were native to the park and family groups only moved into the new area only after a period of 5 to 8 months; and even then the family groups tended to only enter at night and stay for short periods of time before returning to familiar territory (Druce et al., 2008). These observations imply that while the creation of such parks will be beneficial in the long-term, it will not be an immediate solution to elephant overpopulation.

This solution is popular with conservationists as well as the general public but can encounter problems when crossing the borders of neighboring countries and requires political cooperation of all countries involved (van Aarde et al., 2006). Some potential negative effects of dropping fences include weakened ability to monitor poaching, an increased risk of spreading diseases, and reducing tourists' likelihood of seeing desired animals. Despite these risks several areas are being converted into megaparks such as the Greater Limpopo Trans-Frontier Conservation Area (TFCA) and the Kavango-Zambezi TFCA (van Aarde et al., 2006). It is too soon to evaluate the success of such efforts but there is much hope that defragmentation of elephant home ranges will allow their natural carrying capacity to be achieved and reduce elephant damage by giving areas a reprieve from elephant presence as they will be allowed to resume their natural tendency to occupy different areas during the wet and dry season.

Recommendation of Management Strategy

My personal opinion has had been formed, in part by reading the research of others, personal visitation to a park with recently dropped fence lines (Thanda Private Game Reserve, South Africa), and discussions of the "elephant problem" with locals within Kwazulu-Natal, South Africa. I believe that at the stage of over-population that most protected areas have

reached, culling is going to be necessary in the near future. The loss of biodiversity and natural habitat that has been seen in the past 50 years has shown that elephants are undoubtedly causing a strain on the natural working of their ecosystem. Although culling will be unpopular with many tourists, information should be made available to them showing why it is necessary and why it is crucial to raise awareness and funds for the protection of elephants so that this will not continue to be the only solution left for park managers. Culling will only be a temporary solution and so it is imperative that if culls were to be implemented, the time bought with this strategy will be used for further research of more humane methods of population control. I believe that creating mega-parks that allow more natural annual migration is the best way to manage elephant populations in a way that lessens their negative impacts on their ecosystem. By doing this, current areas of high elephant impact would have a recovery period during the elephants' migration as they follow the rains as wild elephant populations do. This method would still provide high-density areas for tourists to observe elephants in their natural habitat; the areas would just differ at different parts of the year. Ideally, individuals to be culled would be selected based upon their genes so that this interference has as small of an impact on the overall fitness of protected elephant populations as possible. By culling groups randomly, natural selection is completely over-ridden and populations that are already at risk of inbreeding have their genetic fitness threatened by artificial selection.

The use of contraception seems a promising lead but it seems unlikely that this will be a practical, large-scale population control method in the near future as there is currently a lack of funding and conclusive evidence of its effectiveness. Translocation is another solution that is popular with the public and has the advantage of increased gene flow between separated elephant populations. Unfortunately, this is not a feasible method for dealing with overpopulation issues

on a continental scale. Translocation is still likely to be used on a small scale to generate revenue for parks but cannot be counted on as a large-scale solution.

I spoke to several South African citizens that would like the trade of ivory, currently being kept in safe locations, to be legalized. This increase in the supply of a coveted good has the potential to lessen the demand and reduce poaching threats that elephants still face. If the money gotten through the sale of this ivory was used for additional research on population management strategies it could also reduce the risk of implementing future culls. This money could also benefit local communities which would give local people a reason to support the conservation of elephants and offset the inclination of people to poach. Opposition to this idea includes fear that with the legal sale of ivory it would become much harder to monitor whether ivory being sold was legally obtained or if it was from a poached animal. This is currently a highly controversial topic but one that I believe deserves consideration. New ways of raising money for the protection of elephants is necessary to avoid facing this problem every few decades.

Conclusion

Decades of successful conservation work has brought the African elephant (*Loxodonta africana*) from being critically endangered to vulnerable (Lombard et al., 2001; Loarie et al., 2009; Smit, et al., 2010). The creation and maintenance of protected wildlife areas has allowed the recovery of this, and many other threatened species by reducing the conflict between humans and the surrounding wildlife, reducing poaching, protecting local livestock, and enhancing the ecotourism market (Lombard et al., 2001; van Aarde & Jackson, 2006; Loarie et al., 2009; Smit & Ferreira, 2010; Vanak et al., 2010). Elephant conservation has been so successful that within

many protected areas, the elephant population has grown to numbers that may not be able to be supported in such small, fragmented landscapes (Lombard et al., 2001; Loarie et al., 2009; Smit, et al., 2010). Wild elephant populations occupy large home ranges and are migratory; two traits that protected herds cannot share (Loarie et al., 2008). Being confined to small home ranges year-round is causing drastic changes in landscape and biodiversity.

Many over-populated protected areas have experienced the conversion from dense wood-land areas to sparse shrub-land or even grass-lands because of increased browsing pressure (Guldemond & van Aarde 2007; Nasseri et al., 2010). Since elephants are selective when choosing trees and shrubs to browse, certain species are more threatened by elephant presence than others and are being carefully monitored so that they do not disappear from areas of high elephant density (Landman et al., 2008; Boundja & Midgley, 2009). Protected areas are committed to the conservation of natural workings of ecosystems and the maintenance of high biodiversity so it is important to limit the negative impacts that more charismatic species have upon others.

Animal species are affected as well as plant species. Small herbivores often benefit from being around elephant herds because it allows them access to food sources that aren't always available in the form of the elephant's leftovers (Makhabu et al., 2006 & Valeix et al., 2011). At extremely high levels of elephant damage, smaller mammals are negatively impacted because the reduced coverage increases risks of predation (Ogada et al., 2008). Complex interactions between elephants and other animal species make it especially difficult for park managers to determine the optimal elephant density and are one of the reasons that decisions about how to handle elephant populations take much consideration.

Several options offer possible solutions to the over-population of elephants protected areas are experiencing such as; culling, translocation, immunocontraception, and creation of megaparks. Each method offers unique pros and cons, which makes the selection of a method difficult for park managers. Culling is extremely effective in the short-term for reducing elephant populations and is a relatively inexpensive option. Some disadvantages of culling includes anger from the public, a possible loss of tourism, possible disruption of natural herd dynamics, emotional trauma to individual elephants, and an over-shadowing of natural selection upon elephant populations (Pimm & van Aarde, 2001; Owen-Smith et al., 2006; van Aarde & Jackson, 2007). Translocation is a great option for areas wanting to expand the gene pool of their elephant population but is not a feasible method of drastically reducing elephant numbers because of the cost of translocation and a lack of parks able to accommodate large quantities of additional elephants (van Aarde & Jackson, 2007). Immunocontraception is a relatively new and under-researched method of population control. It is much more popular with the public than culling but is a very expensive and time costly option. It is still unclear what affects contraception will have upon herd dynamics and may cause individuals great stress (van Aarde & Jackson, 2007). More research is needed before using this method on a large-scale. The creation of mega-parks is becoming a more popular option for elephant population control because it allows a more natural home range for elephant herds than what is available in most protected areas. These parks are difficult to establish because they require the cooperation of many areas and often different countries (van Aarde et al., 2006). Not all parks are willing to join with other nearby protected areas to form these megaparks. Unfortunately this method would take a long time before seeing significant changes in the distribution of elephant herds.

Many aspects must be considered by park managers when making decisions about how to handle over-population of elephants. More research is needed to know the exact impacts that these elephants are having on their surroundings. Hopefully, this additional research will also help managers choose the management strategy most appropriate for their situation. This is a very complex issue that deserves careful consideration. Hopefully a long-term strategy can be implemented that will prevent this problem from arising in the future.
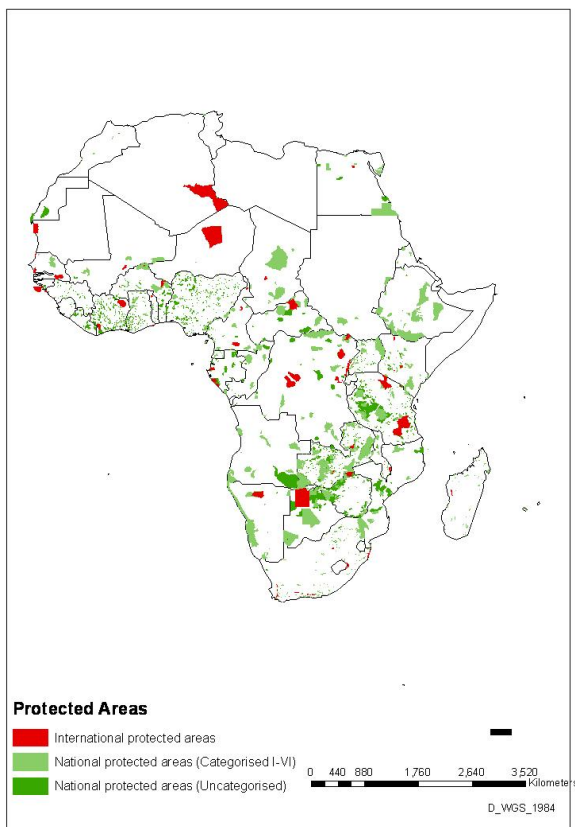

Figure 1: Protected Areas of Africa

Figure 2: Current distribution of African Elephant Populations

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