# Reintroduction of the eastern black rhino (Diceros bicornis michaeli) to Serengeti National Park

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## Introduction & History

As initially conceived my goal for this project was to do a comparative analysis of the recent re-introduction of eastern black rhino (*Diceros bicornis michaeli)* to the Serengeti with other black rhino and large herbivore re-introductions, as well as general wildlife restoration principles (Morrison 2002, 2009). However it quickly became clear that this re-introduction is fairly unique and comparison to other large herbivore restorations isn't that useful due to the vastly different techniques and special species requirements. Comparison to other black rhino re-introductions is useful, however the main technical team for the Serengeti project is the Frankfurt Zoological Society team, which ran the other black rhino introductions using largely the same methodologies.

Rhinos are megaherbivores, and a flagship species for international conservation. They along with lions and elephants are symbols of protection of African savannas. There are five species of rhinoceros, three in Asia, two in Africa. The two species of African rhinoceros are the black rhino (*Diceros bicornis)* and the white rhino (*Ceratotherium simum*), both have been driven to near extinction over the past century. The two species can be easily distinguished by the shape of their mouths and overall body size. White Rhinos are larger with distinctive broad, straight mouth which is used for grazing grass. The black rhino is much smaller and has a long, pointed, prehensile upper lip, which it uses to grasp leaves and twigs when feeding.

***Table 1:** The four subspecies of black rhino's current and historic range (IUCN 2008b)*

| Black Rhino Subspecies | Historic Range | Present Range |
|---|---|---|
| **Eastern Black Rhino**<br>*Diceros bicornis michaeli* | Southern Sudan<br>Ethiopia<br>Somalia,<br>Kenya<br>Northern half Tanzania<br>Rwanda | Kenya<br>Tanzania<br>South Africa (transplant stock)<br>Rwanda (?) the last confirmed rhino found was poached in 2005. Rumors of one more. |
| **Southwestern Black Rhino**<br>*Diceros bicornis bicornis* | Namibia<br>Southern Angola<br>Western Botswana<br>Southern South Africa | South Africa<br>Namibia |
| **South Central Black Rhino**<br>*Diceros bicornis minor* | Southern Tanzania<br>Zambia<br>Zimbabwe<br>Mozambique<br>N. South Africa inc. Swaziland<br>DR Congo<br>Northern Angola<br>Eastern Botswana<br>Malawi | South Africa<br>Zimbabwe<br>Southern Tanzania<br>Reintroduced to Botswana, Malawi, Swaziland and Zambia. |
| **Western Black Rhino**<br>*Diceros bicornis longipes* | Central-west African Savannas | (?) Cameroon<br>presume extinct since 2006* |

*There are no animals in captivity nor have surveys found any in recent years (Amin *et al* 2006).

Black rhino once inhabited a variety of habitats from desert areas in Namibia (*Diceros bicornis bicornis*) to wetter forested areas. However the highest densities of rhinos are found in productive savannas and in succulent valley bushveld areas. Black Rhino are browsers favoring small Acacia's and other palatable woody species (*Grewia* ssp., *Euphorbiaceae* spp. etc.) as well as palatable herbs and succulents, eating branches, stems, twigs and foliage (tricky when faced with vicious 3-inch Acacia thorns). The white rhino is more a creature of the plains, a grass grazer of savannah and open grasslands.

Despite its more limited range, the white rhino is faring better than the black rhino, and is listed as "Near Threatened" with about 17,500 in the wild (Emslie 2008, IUCN 2008b). Starkly low real numbers, but in relative terms there are a plethora of white rhinos when compared to the "critically endangered" black rhino at over 4,200 (Emslie 2008).

In the 1960s it was estimated that the population of black rhinos stood at over 100,000 in the wild. The cause of the decline in addition to habitat loss is poaching for the rhino horn trade (IUCN 2008b), this was especially heavy in the 1970s. Since then the coupled effects of increased enforcement and simply there being less rhino, has lead to a decline in poaching. Another and more tragic threat to rhinos stems from human failures and tragedy: War, civil unrest, corruption in many range states combine to kill rhino directly due to the easy access to high powered weapons, facilitate the black market trade in horn, and poverty-stricken people hunt rhino to survive.

The four subspecies of black rhino occur in different areas (table 1), although overlapping, there are major differences in the core areas of their distributions, and it's likely that each has adapted genetically and behaviorally to its environment (Emslie and Brooks 1999).

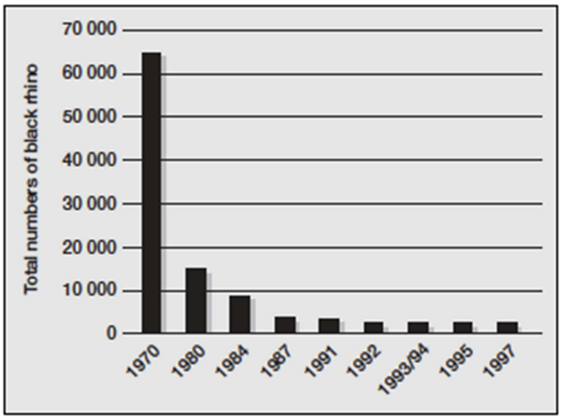
All black rhino subspecies are classified as critically endangered. The eastern black rhino last assessed in 2008 by IUCN SSC African Rhino Specialist Group, remains critically endangered, unchanged since 1996. The eastern black rhino is the most endangered of the black rhino, with only an estimate 700 left in the wild in Kenya and Tanzania.

An effort is currently underway to restore the historic Serengeti population of eastern black rhino. Central to this project is the re-introduction of 32 eastern black rhino from South Africa to the Serengeti, the first group of these were released into the Serengeti in July 2010. We shall don our ecological restoration hats and review this re-introduction for overlaps with restoration principles.

## Black Rhino History

When viewed through restoration lens, the first step in analysis is historical records. (Clewell and Aronson 2007, Grese *pers comm* 2010). It's been estimate that up to the beginning of the 19th century black rhinos were the most numerous of all rhino species, numbering in the hundreds of thousands. Following the invasion of European colonizers and their influence over land-use and trade strengthened, the rhino were hunted relentlessly continent-wide. One latter example hints at the carnage. Between 1946 and 1948 1,000 rhino were shot in the Makueni area of Kenya alone as it was prepared for agriculture (Brett 1993). It was considered a pest (Emslie *et al* 2009). Multiplying this to continental scale, it's easy to explain the decline, akin to the slaughter of North American bison.

Despite these challenges there were an estimated 65,000 black rhino in 1970. Poaching pressure increased in the 70s and 80s, when increased demand for horn in Asia coincided with a period of economic and political instability across the continent (IUCN 2008b). This left poachers with high incentive and relative free reign to hunt rhino with little fear of apprehension. Combined, this lead to a drastic 96% decline in rhino numbers over the next twenty years (figure 1), the decline




**<u>Figure 1:</u> The decline of *Diceros bicornis* between 1970-1997** (Emslie & Brooks 1999).

from 1970 to 1980 is quite jaw dropping.
This was one of most rapid declines of any large mammal. The population hit a low point in 1992 at 2,410 (Emslie and Brooks 1999). Since then however populations in the best protected and well managed populations have been increasing (offsetting the continual decline in other areas), with continental estimates at 4,230 in December 2007 (Emslie 2008, Milliken et al 2009).

## Threats

One of the main and the most widely publicized threats to black rhino population is poaching for the international rhino horn trade. Rhino horn has two main uses: traditional use in Chinese medicine, and ornamental use (Emslie and Brooks 1999). Rhino horn is a highly prized material for making ornately carved handles for ceremonial daggers (Jambiyas) worn in some Middle East countries.
Another threat to rhino populations, common to most wild species, is habitat loss and fragmentation. As human populations continue to grow in sub-Saharan Africa, so does land conversion and habitat fragmentation.
A third and sometimes less obvious threat is warfare and civil unrest in various countries throughout the rhino's range. The free-flow and easy availability of weapons is a challenge to conservation and to ill-equipped anti-poaching teams. Black rhino populations have been impacted by warfare in numerous countries including Chad, Democratic Republic of Congo, Rwanda, etc since the 1960s. Such unrest exacerbates the historic general lack of political will and low conservation expenditure. This lack of social stability and crippling poverty increases the allure of poaching rhino for horn and bushmeat, while funds are diverted from rhino conservation to other areas.
Additionally black rhinos are very susceptible to disturbance, and will vacate areas frequently used by humans. Evidence shows that rhinos will not approach within 10km of a road (Gadd *pers comm* 2010*).*

**Rhino & CITES**
The United Nations Environment Programme's Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), is a well known international agreement between governments, signed by 145 countries, to ensure trade in wild animals does not threaten their survival. CITES is divided into three Appendices, according to the degree of protection a species may need. Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. CITES can into existence in 1975, recognizing the dire danger in trade in rhino horn, Black rhino were listed just two years later on CITES Appendix I in 1977, and have remained there ever since (UNEP-WCMC 2010).
The CITES and concurrent domestic bans in rhino horn trade were needed, and they stemmed the flow of horn. But, for those willing to take the risk, the bans have driven the trade underground, inflating prices, making killing rhino even more lucrative. Due to this well-equipped and armed poachers can devote a lot of time and energy to hunting rhino because of the large payoff. The markets for rhino still persist thirty years after the CITES ban, as long as the market are there, so is the threat.

## Rhino Population Levels & Dynamics

Encouragingly the IUCN currently categorizes all the rhino population as increasing. The south-central black rhino is the most numerous of the black rhino species (table 2). Besides the now likely extinct Western Black Rhino, the eastern black rhino is the most endangered subspecies with an estimates at 700 individuals. As of 2005 there are currently an additional 171 eastern black rhino in captivity (Emslie *et al* 2007). Namibia and South Africa have the largest populations' of rhinos (table 2). In recent years black rhino numbers have remained stable in the major range states, where most animals are now better protected in smaller sanctuaries where law enforcement effort can be concentrated.

***Table 2:* Estimated African black rhino populations by country as of December 2007**
*(adapted from Milliken* et al *2009).*

| Country | South-western *D.b. bicornis* | Eastern ***D.b. michaeli*** | South-central *D.b. minor* | Country Total |
|---|---|---|---|---|
| **Botswana** | | | 7 | 7 |
| **Kenya** | | **577** | | 577 |
| **Malawi** | | | 16 | 16 |
| **Mozambique** | | | ? | ? |
| **Namibia** | 1,435 | | | 1,435 |
| **Rwanda** | | **1**** | | 1 |
| **South Africa** | 113 | **54*** | 1,321 | 1,488 |
| **Swaziland** | | | 18 | 18 |
| **Tanzania** | | **67*** | 56 | 123 |
| **Zambia** | | | 16 | 16 |
| **Zimbabwe** | | | 546 | 546 |
| **Subspecies Total** | 1,550 | **700 Total Eastern** | 1,980 | **4,230 Total Black Rhino** |

* Following the re-introduction in 2010 these numbers have changed.
** The single *D.b. michaeli* in Rwanda was confirmed killed in 2006, but Rwandan officials have reported the existence of another eastern black rhino (Emslie 2008)

The current fragmented state of rhino populations is driven home by the classification labels that each type of population falls into: Captive, Wild, Semi-Wild, in Situ, ex situ, Sanctuary, etc. Leader-Williams et al (1997) devised key diagnostic features to distinguish three types of rhino populations: wild, semi-wild, and captive:

- The size of the area they occupy
- Breeding Natural or manipulated (pedigree analysis)
- Degree of compression (artificially high animal density), food supplementation, husbandry and veterinary care

These run the gambit from no management to high levels of management with supplemented feeding, mate selection, veterinary intervention etc.

**Wild Populations**

This refers to free ranging wild rhinos that generally live within the historic range of the species at natural density and spacing and with natural breeding. Wild populations do not have supplemented feeding, and only receive occasional veterinary attention. These individuals live in larger areas (>10km$^2$)

**Semi-Wild Populations**

These rhino populations occur in smaller areas (<10km$^2$), that can be inside or outside of the historic range. They live at compressed density levels and require routine supplemental feeding with a high degree of management. Crucially, these populations breed naturally.

**Captive Populations**

These rhinos occur in small areas (<1km$^2$), that can be inside or outside of the historic range. These types of populations have compressed densities, are supplementarily fed, with very high management, husbandry and veterinary oversights. These populations breedings are manipulated.

These population distinctions are important to bear in mind, because with such small numbers and with rhino re-introductions, some populations are sources for re-introduced animals or are sources of new genetic input into a population. And as the importance of local genotypes is further understood, the choice of mate or source animals for a reintroduction can be crucial (Morrison 2009). Managers of these differing rhino populations must bear these factors in mind, so as to manage the populations so that they are appropriate for the site, while also maintaining healthy genetic diversity so that their animals could potentially serve as a source of re-introduction animals. Thus efforts moving animals between the population types are increasing as efforts to restore black rhinos continue. Emslie *et al* (2009), argue that translocations and reintroductions will be key to the black rhino's continued survival and population growth.

**High Conservation Value Populations**

Within the three categories of populations the IUCN/SSC African Rhino Specialist Group (Emslie and Martin, 1999) has identified procedures for identifying key and important rhino populations. These are populations with the highest conservation value. *Key populations* are those whose survival are critical for the wider survival of the subspecies, while *important populations* those considered extremely valuable to the survival of the subspecies.

There are three main parameters by which to judge the conservation value of a population:

- Population Size
- Significance of the population to conserving that subspecies
- Likelihood that any protection/conservation measures will be effective

The third parameter is especially important as donor and conservation money must be increasingly targeted, and thus should be used on populations that are stable or expanding, rather than trying to reversing unstable population where management programs are poorly developed or non-existent.

This is a bitter pill to swallow, as struggling programs should be encouraged not shunned, however in the chaotic zeitgeist of many of the rhino's range countries, with limited money, this is the only option. Before 2000 there were no key black rhino populations in Tanzania, but one important population (Emslie and Martin, 1999). The important population is undisclosed, due to poaching, but if I had to guess it would be those in the Selous Game Reserve. Across the border in Kenya, there were 2 key and 6 important populations. However at the end of 2007 there was one key and two important black rhino populations in Tanzania, and six key and five important populations in Kenya (Emslie 2008). One of the Kenyan populations is at the Masai Mara National Park which adjoins the Serengeti National Park. With the reintroduction of rhino to the Serengeti, there's potential to connect and expand the Masai Mara and Serengeti populations.

With the increase in both key and important populations of rhino in Tanzania, was one of the factors playing into its choice as a re-introduction site.

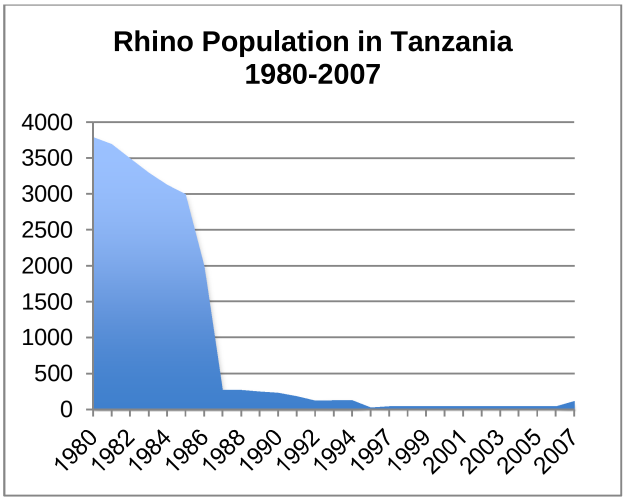
**Eastern Black Rhino**

The eastern black rhino is slightly smaller than other black rhinos, and has larger, more slender horns, often with prominent skin ridges which gives them a corrugated appearance.

Currently there are about than 700 eastern black rhino. The only surviving wild populations of *D. b. michaeli* are in Kenya, (approximately 577 individuals in 16 areas), and northern Tanzania (approximately 67 individuals in three areas). It is of particular concern that all of these subpopulations have fewer than 100 individuals, rendering them susceptible to the risks of extinction inherent in small populations (Morrison 2002, 2009).

This reintroduction will bolster the transnational Serengeti-Mara population, making it the largest free-ranging population of eastern black rhino subspecies. An estimated 500 - 700 black rhinos roamed the Serengeti-Mara Ecosystem some 40 years ago before illegal hunting almost drove them to extinction. Between 1977 and 1978 the entire black rhino population within the ecosystem was reduced to only 10 individuals.

## Tanzanian Rhino




| Black Rhino Population Estimates for Tanzania | |
|---|---|
| **1980** | 3,795 |
| **1984** | 3,130 |
| **1987** | 275 |
| **1991** | 185? |
| **1992** | 127 |
| **1993/4** | 132 |
| **1995** | 32 |
| **1997** | 46 |
| **2007** | 123 |

**Figure 2 & Table 3: Estimated population dynamics** *adapted from Emslie and Brooks (1999) and Milliken* et al *(2009).*

Until recently, the story of the Tanzanian rhino is a sad one, although records for all black rhino sub-species are spotty and sometimes contradictory, using species level black rhino as a gauge, it's pretty grisly stuff (figure 2 and table 3).

Thirty years ago Tanzania was one of the three best range states for black rhino, but in 15 years the population was nearly eliminated due to poaching. Even where a population is well known, and well protected, poachers can still be a problem, as evidenced in the isolated small area of the Ngorongoro Crater, between 1992 and 1997 poached killed seven rhino, reducing the population form 20 to 13 (Emslie and Brooks 1999). This hints at the greater problem in rhino conservation, the cost and intense monitoring needed to protect the animals. If they can do it in the heavily trafficked and small Ngorongoro Crater, what hope is there for the open plains of the Serengeti?

Following the success of poachers during the 1970s and 80s, the Tanzanian government declared war on poaching, beginning in 1990 (Fyumagwa and Nyahongo 2010). It launched *Operesheni Uhai,* a Kiswahili phrase meaning 'operation save life', which coincided with the world ban on ivory trade (Sinclair 1995). This initiative included increased enforcement actions as well as a large public awareness campaign. Following this initiative, anti-poaching patrolling and security was beefed up in both the Selous Game Reserve and Ngorongoro Crater, however there are still security concerns around the northern Serengeti area.

Three years later, a formal national plan was developed for the Tanzanian rhino, which was reviewed and updated in 1998, including appointing a national rhino coordinator. The goal is to increase the metapopulations of *D. b. michaeli* and *D. b. minor* to 100 by 2018, with each subspecies population to increase 5% annually (Emslie and Brooks 1999). For a country that has set aside a staggeringly high 28% of its land for wildlife and conservation, the stage is set. Such optimism is tempered though as manpower and budgets will limit areas that can be protected effectively.

The efforts to bolster black rhino with reintroductions in Tanzania began in 1997, since that time there have been five reintroduction events. Including two black rhinos from South Africa were translocated to Ngorongoro crater, as well as eight South African, and three Czech Republic rhinos have been released in Mkomazi National Park. An interesting event occurred in 2001, when a group of 10 black rhinos wandered into the Serengeti from Masai Mara Natural Reserve in Kenya, likely in response to disturbances on the Kenyan side (Norton-Griffiths 2007). This was a bright sign that the poaching pressure in the northern Serengeti had subsided, considering the rhinos moved in there of their own volition. The success of these rhino, hinted that the area was suitable for further re-introduction.

**The Serengeti-Mara Ecosystem**

Perhaps THE iconic ecosystem of Africa. All included at 27,000 km$^2$, it is the one that springs to mind in many westerners via of the continent, endless tree-spotted plains filled with charismatic megafauna.

In the north-western part of Tanzania, the Seregeti-Mara ecosystem straddles the Tanzania-Kenya border in East Africa. The core is protected by the Serengeti National Park in Tanzania, and by the Masai Mara national Reserve in Kenya. The core parks are buffered by surrounding conservation areas. The boundaries of the ecosystem are roughly defined by another icon, the annual migration of 1.5 million wildebeest. The system changes from grasslands in the more arid areas along a gradient to the more woody, shrub, wetter area in the north west. The area is not fenced, allowing for movement and exchanges though all the protected areas. Such a vast system offers a huge swatch of fully functioning ecosystem, largely unpopulated by humans.

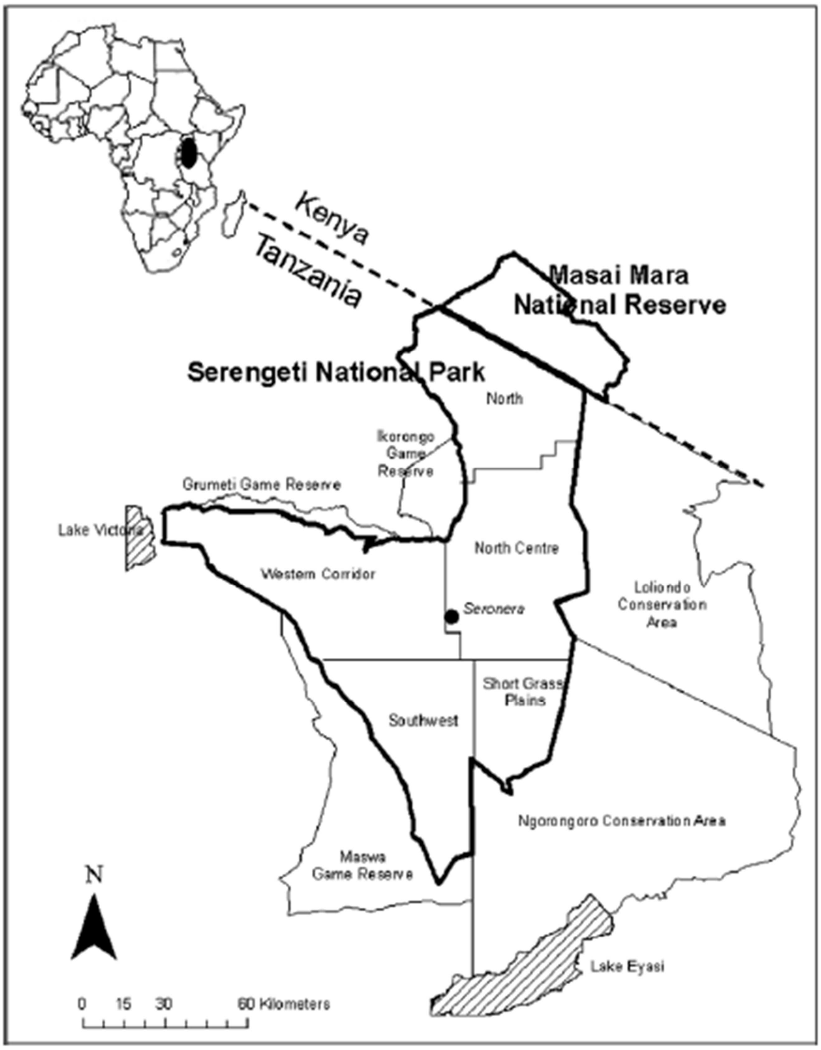



**Figure 3: The Serengeti-Mara Ecosystem showing the core and surrounding protected areas** (Metzger *et al* 2007)

**Historic Serengeti Rhino Range and Habitat**

The black rhino population in Serengeti National Park was estimated at about 700 individuals in 1974 (Frame 1980). During his work on Serengeti rhinos in the 1970s, Frame (1980) observed that black rhino ranges there ranged between 40-133km$^2$, with a lot of overlap in the ranges. The sex ratio observed was about 3 males: 4 females.

Within the Serengeti, two factors lead to the high rhino poaching activities (Makacha et al 1982):

- The increase of population and other anthropogenic activities close to the Park boundary
- Increased landscape fragmentation and human disturbance blocked traditional wildlife corridors.

There is clearly a need to expand black rhino habitat. Or put more precisely, burgeoning successful eastern black rhino populations need access to more habitat. Some populations of the eastern black rhinoceros in enclosed areas appear to be overstocked and are showing clear signs of density-dependent reductions in reproductive performance. In some cases competition from other browsers, such as African elephants (*Loxodonta africana*) and Giraffes (*Giraffa camelopardalis*), appears to also be negatively affecting rhinoceros carrying capacity (Amin *et al* 2006).

For a Tanzanian example of rhinos looking to expand into new habitat, highlighting that there is movement and will be mingling of rhino populations. For example, bull rhinos have left the Ngorongoro Crater (a protected area beside Serengeti National Park) to escape the high levels of aggression and territorial disputes in the Crater. These jailbirds are currently tracked down, caught and returned to the Crater or other areas they escaped from.

Such pushing back is not a permanent solution as populations continue to increase, additionally this will lead to artificially high density and stress, increasing aggression, and thus to depressed reproduction. There is clearly a need for access to more protected habitat, and for connecting areas from which rhinos are ripe for dispersion (Fyumagwa and Nyahongo 2010).

## Serengeti Reintroduction

The decision to translocate rhino is a large one, both physically and fiscally. I may have beat this horse to death, but black rhino populations, especially eastern black rhino populations are perilously low. *D. b. michaeli* is currently restricted in the wild to Kenya and Tanzania (plus the population in the South African reserve). The few protected areas in Kenya with eastern black rhino are reaching or have reached carrying capacity (Emslie and Brooks1999). The Serengeti-Mara Ecosystem represents the best potential site for population growth of the Eastern black rhinoceros (Thirgood et al., 2005). Here populations remain low (Metzger et al 2007) in a system with historically higher rhino numbers, and adequate room for a re-introduced population. Fair play to the organizers of the reintroduction, the eastern black rhino is reportedly the most aggressive type of this already grumpy species…

Organizationally, it truly is a multi-stakeholder project, which matches the complexity, size and cost of the operation. The project is a partnership between the Tanzanian Ministry of Natural Resources and Tourism, Tanzania National Parks (TANAPA), the Tanzania Wildlife Research Institute (TAWIRI), South African National Parks (SANParks), Frankfurt Zoological Society (FZS) and the Grumeti Fund (the NGO of Singita-Grumeti Reserves Ltd.).

A private conservation organization in the Serengeti ecosystem (Singita-Grumeti Reserves Ltd.) which runs the Ikorongo and Grumeti Game Reserves (figure 3) adjacent to the Serengeti National Park has a long-term plan to translocate black rhinos into the Serengeti ecosystem. In 2006 the Singita-Grumeti Reserves Ltd acquired 32 black rhinos from a private game ranch, Thaba Tholo, Thabazimbi in South Africa. It is this population that is being re-introduced (Fyumagwa and Nyahongo 2010) likely over a five-year period (Hartstone 2010).

## Risks and Threats Associated with Re-Introduction

### Poaching

Finally, some good news! The reading thus far, does not paint a very bright future for rhinos in Tanzania. However, as a result of the Tanzanian government's initiatives mentioned earlier, including strengthened law enforcement, there have been no reports of rhino poaching over the past 14 years (Fyumagwa and Nyahongo 2010). One could question whether this is solely due to stricter law enforcement, or a function of there being so few rhino. With so few animals, they can be monitored pretty well, and there is really no incentive to poach. As the metapopulation

(hopefully) grows, enforcement will become diluted, plus there will be more rhino, giving more opportunities and incentives to poaching gangs. In the future, will the balance between enforcement and poaching pressure ultimately dictate the population dynamics of black rhino?
In the northern Serengeti area of reintroduction, the 10 rhino that wandered in from Kenya do face a potential threat, as historically poaching was high in this area (Frame 1980), and there is high poaching close by outside the Masai Mara reserve (Fyumagwa and Nyahongo 2010). However a bi-lateral agreement allows for trans-boundary anti-poaching patrols, increasing security. Additionally this refugee population has garnered a lot of attention from conservation NGOs, adding resources to the monitoring (Du Plessis, *pers comm* 2009).

**Genetics & Sex Ratios**

Re-introductions and translocations themselves offer some threats. While introducing new animals improves the genetic diversity of small populations. Caution is needed:

- Introduced animals should be screened for deleterious genetic material and for infectious disease.
- While genetic variability is the goal, the choice of reintroduced animals should come from the appropriate sub-specific genotype and as local as possible to avoid hybridization and loss of locally adapted genes. A crucial area for future research is to map the genetic diversity of the various metapopulation fragments (Fyumagwa and Nyahongo 2010).
- The overall natural sex ratio of the population should be maintained.

The translocation of 32 black rhinos by Singita-Grumeti Reserves Ltd into one ecosystem is likely to compromise the ability of management authorities to provide adequate protection to both indigenous and introduced populations. However, it could be a recipe for preventing the inbreeding problem in these small isolated rhino populations through introduction of new genes (Fyumagwa and Nyahongo 2010, Emslie *et al* 2009).
Following the 1997 reintroduction to Mkomazi, it took eight years before the rhinos bred in the wild, despite having a similar sex ratio to earlier observed populations (Fyumagwa and Nyahongo 2010).

**Predation**

It is hard to get a good estimate on the relationship between predators and black rhino. Most of the observations come from the somewhat artificial area of Ngorogoro Crater. Here the spotted hyena (*Crocuta crocuta*) densities are especially high at approximately 400 in 250 $km^2$ (Honer *et al* 2006). Predictably rhinos are most vulnerable when they are young, and the tendency of the black rhino calf to follow its mother (rather than being herded ahead of the mother as in white rhino), leaves the calf more vulnerable to predation. Hyenas (particularly) and lions have been observed taking calves. Predation of rhino calves in other rhino populations in Tanzania has not been reported, likely due to the low density both of rhino and of large predators like spotted hyenas in the respective areas.

**Management Challenges**

Fyumagwa and Nyahongo (2010) include some interesting challenges to rhino conservation. As rhinos are an international flagship species, it often gets caught in political and oversight issues. With many local, national, international governmental and non-governmental organizations claiming a stake in the rhino, sometimes sub-optimal outcomes are negotiated. Many different authorities in Tanzania manage the various fragmented populations separately. Thus the continuing challenge going forward is the coordination of all these management groups and activities. For instance there can be a lot of inertia when a proposal to relocate rhino between populations, etc. However, I disagree with Fyumagwa and Nyahongo (2010), at least at higher scale activities. My sense is that the IUCN Rhino Specialist Group is widely recognized as the oversight team for rhinos, at least in Africa, and they have been active in developing and coordinating strategy, as well as developing guidance materials such as Emslie *et al* (2009) and du Toit *et al* (2006).
However with the recent spate of re-introductions, national and international stakeholders should again convene and decide upon a strategic plan for the Tanzanian rhino, to better align all the stakeholder’s activities.

**Habitat Fragmentation, Human Encroachment and Human Population Growth**

This is the same problem as faces many species worldwide. However, being a large herbivore with ranges of 130 $km^2$ plus, rhino can feel these affects more acutely.

One recent issue of major concern is the announcement by the Tanzanian government of a potential commercial road through the northern Serengeti (Williams 2010). This has garnered international outcry, and is a surprising announcement from President Kikwete, who until recently has been lauded for his conservation work. Besides interrupting the famous annual migration of wildebeest and other ungulates, this road will further fragment habitat right at the core of where the rhino are being re-introduced. Likely bringing development, traffic and presumably poachers. Additional evidence from the recent road built though Mkomazi National Park, black rhino will not approach within 10s of kilometers of a road (Gadd *pers comm* 2010).

The area to the west of the Serengeti is becoming increasingly densely populated, stemming form the cities on Lake Victoria. The eastern border is not heavily populated. However there are expanding semi-urban populations spreading from the hubs of the Arusha area.

**Other threats**

Disease (such as babesiosis, a tick-borne disease), however this has been less of an issue, with only one report of an ill female in 2000 (Nijhof et al 2003). There have been no reports of disease problems among the other two rhino populations at Selous Game Reserve and Serengeti National Park, which is a sign of healthy rhino habitats (Fyumagwa and Nyahongo 2010).

These threats must be addressed to allow for successful eastern black rhino restoration. One of the tenets of ecological restoration is to eliminate or ameliorate the causes of disturbance or degradation that are disrupting and destroying the ecosystem (Clewell and Aronson 2007, Grese *pers comm* 2010). Such actions, similarly, are vital to the success of reintroductions.

In addition the continuing tandem actions of anti-poaching patrols, monitoring as well as education, training, involving and getting the goodwill of the local communities are vital to success and viability to the existing and reintroduced populations. Involvement of the communities adjacent to the Serengeti will become increasingly more important, as if reintroductions continue it is likely that rhinos will range outside of the park boundary.

## Serengeti Rhino Repatriation Project

Although the movement of thirty-two 1100kg rhinos across half a continent seems to be the biggest job of this project, it isn't. As with other restoration projects, the actual dirty (and fun) hands-on the groundwork is often one of the lesser components. For rhinos, add in well-armed poachers and vast landscapes it adds even more dimensions. The largest parts of this project was finding the appropriate, and safe release site, as well as training and bolstering the law enforcement, and ecosystem protection systems, and to find the budget to do all that.

In reviewing the methodology for rhino reintroductions from a restoration perspective, the elements that most overlapped with restoration thinking were stock selection, site selection and animal transfer and release. Beyond encouraging breeding of rhino in the various population types (wild, semi-wild, and captive), there is little other 'intervention' in a restoration sense, no plantings, invasive removals etc. Which makes sense the sites chosen for re-introductions occur in resilient fully functioning ecosystems of a large area to promote growth of the reintroduced population, otherwise what's the point of translocating?

To a larger extent these core elements of a rhino re-introduction occur in all re-introductions (appendix 1), in fact using lessons learned and best practices the IUCN/SSC have developed comprehensive guidelines for rhino re-introductions (Emslie *et al* 2009). Using the case study of the recent Serengeti reintroduction, these methods will be explored. This case study was also chosen for it's unique use of predictive modeling for suitable rhino habitat in the planning stage.

**Stock Selection**

The Animals chosen for re-introduction and in effect repatriation come from a South African reserve. In 1961 seven eastern black rhino were caught at Tsavo National Park in Kenya (home of the famous man-eating lions of Tsavo) and were sent to South Africa.

The Tsavo group was sent to South Africa during a period of high poaching. Over the intervening 50 years this South African population of *D. b. michaeli* has grown to over thirty. It is the descendants of the seven rhino that are being re-introduced into the Serengeti. The goal is to move 32 rhino. Critically these expat Kenyan rhinos were kept separate from South African rhinos, to avoid hybridization with other sub-species. They do carry the risk of the founder effect from the seven initial individuals.

The choice of these animals seems sound from a restoration perspective, they are the same sub-species as existed in the Serengeti, and they are from a relatively nearby area in Tsavo. Emslie *et al* (2009) give many criteria to consider when choosing the stock animals. These were less important in this case, as all 32 animals were bought as a group, the whole population, so there was no selection of individuals. The rhino reintroduction guidelines (Emslie *et al* 2009), call for the transplant of more than 20 rhino to an initially when the expected population will be more than 50 in total, so with 32 they're in the clear

Ideally the re-introduction animals would have been chosen from animals that once roamed the Serengeti, to ensure the closest possible genetic match to the historic population. All told 32 *D. b. michaeli* rhino will be re-introduced into the Serengeti over the coming 2-3 years. They will form new sub-population in the Serengeti National Park where they will create a link to an existing sub-population of Eastern Black Rhino and hopefully bridge the gap to one another. This will be the largest relocation of its kind, ever. The first group arrived this past spring.

**Site Selection**

Perhaps the area of wildlife restoration (that does not require habitat restoration) that has the greatest overlap with traditional ecological restoration is the site selection process. For the Serengeti project the coupled use of historical records and comprehensive analysis and modeling of current landscapes to identify the most appropriate site for release, overlaps with many of the stages of a typical ecological restoration project (Clewell and Aronson 2007).

I couldn't resist this quote, I think it encapsulates how many of these types of projects start, from very informal conversations:

*"Here is a little background on the rhino. Tony (Sinclair) was out in Serengeti and the Rhino specialist group approached him and said ' we have a bunch of rhinos we want to out into the Serengeti and we know there are a few rhinos in this area now so that is where we think we should put these new ones' and they pointed to some place on the map. Tony was working in Tanz before the collapse of the rhino population and he had remembered seeing them all over the place so instead of just putting them where there were a few rhinos now we dug through old data and found some spatial information rhino and did a thorough analysis of where might be a good location based on a number of factors (poaching risk for one)."* (Metzger *pers comm* 2010).

I think the key to note here is "there are a few rhinos in this area now so that is where we think we should put these new ones' and they pointed to some place on the map." Thus the Rhino Specialist Group was using present distribution as an indicator of best conditions. Assuming (probably) that the current rhino moved to inhabit the best possible habitat.

Current distributional patterns are generally a strong indicator of good habitat for the species of interest. At first glance this looks like a sound line of thinking. However, with more thought, for a species with such low numbers, could a remnant population of a few animals be an indicator of habitat quality? Or from a different perspective, is it an indicator of sub-optimal habitat? Where the animals are merely existing, because they cannot access high quality habitat due to human disturbance, poaching, habitat fragmentation or by being outcompeted by replacement spp.? This is especially true for long-lived species such as rhino, because we do not know the dynamics of that population, is it growing, or declining? Is there recruitment? Additionally the area inhabited might be viable for a small population, but with the addition of re-located animals will this habitat become suboptimal?

Metzger *et al* (2007), delved into the Rhino Specialists Group initial presumption, questioning whether or not the current inhabited area offers the best conditions for relocation. This work is a pretty exquisite example of the use of historic records, remote sensing, GIS layering and modeling of numerous factors to predict the most viable habitat for rhino reintroduction. And it was the first time this type of modeling was used in these projects.

To oversimplify their efforts, the team developed a habitat suitability model with numerous inputs. Corrected historical rhino counts and records were spatially located and matched/explained with current vegetation and landscape variables (appendix 2). Since poaching is an ever-present danger/temptation, probabilities of areas with highest likelihood of illegal hunting coupled with the probability of a rhinoceros being found and targeted were also added to the model.

To help determine the risk, the team looked at cultural norms of the surrounding residents.

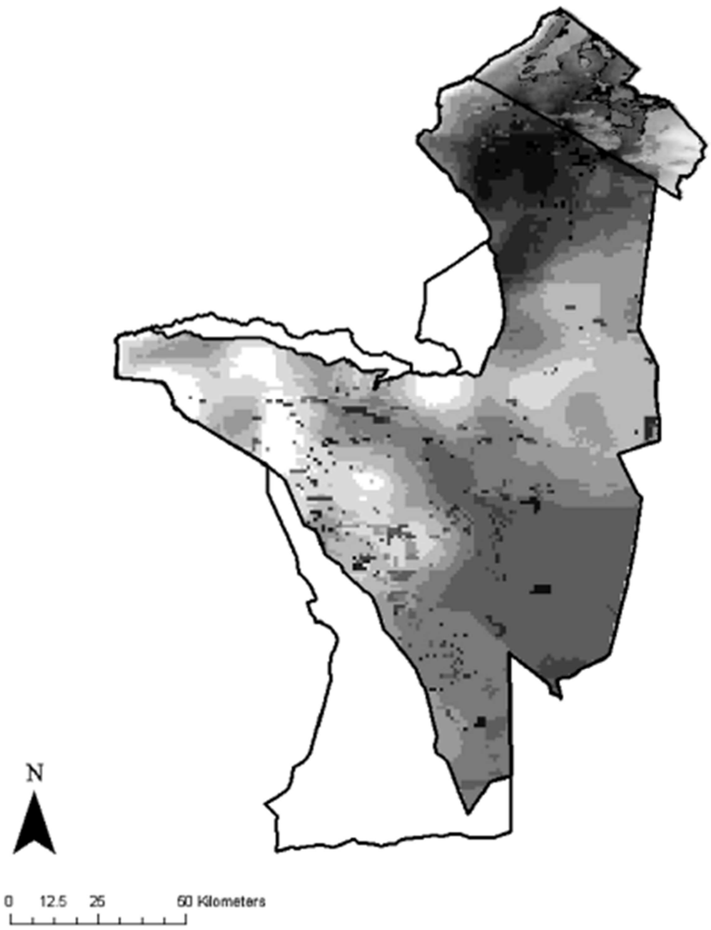



**Figure 4: Reintroduction suitability derived by merging habitat suitability & poaching risk. Darker areas show better areas for reintroduction** (Metzger *et al* 2009).

In broad terms the population to the east of the Serengeti/Mara system (population 136,000) are mainly masai and pastoralists that do not eat game meat. In contrast the dense agricultural population on the western borders of the area total about 1.9 million people, and use game meat. Thus the poaching threat is higher in the western areas of the park, based on a previous analysis which found that the number of hunters in an area was a function of the population size and distance to reserve boundary (Campbell and Hofer 1995). In summary, poaching risk was modeled using human density, locations of people found in the park and rates of killing of animals commonly hunted by people.

The habitat suitability and the risk assessment maps were combined, and used to identify areas that maximize suitable habitat and minimize risk from illegal hunting (figure 4). In reviewing for re-introduction suitability, for habitat the north-west sections predicted highest rhino density, but it also had high poaching risk. The western corridor offered moderate habitat but very high poaching risk, while despite the lower poaching risk to the east and south, habitat had poor suitability. Balancing all factors the northern part (especially farther from the western edge) of the Serengeti ended up being the best location for reintroduction.

One area of analysis that could have been overlooked is secondary plant chemicals in certain plants. Because of this much woody plant browse (especially many evergreen species) in some areas is unpalatable. Failure to appreciate this, has in the past led to carrying capacities being over-estimated in some areas. (IUCN 2008). Apart from plant species composition and size structure, black rhino carrying capacity is related to rainfall, soil nutrient status, fire histories,

levels of grass interference, extent of frost and densities of other large browsers. While some of these were covered in the models, not all were. That said, the analysis we incredibly thorough.
The work had to be thorough, as it is very hard to use theory to argue against current range of rhino. Especially as the modeled area currently have no rhino. The modeled best release area was further verified through the IUCN-Rhino Specialist Group's approved habitat quality assessment technique. Astonishingly though it worked, and based on this model the re-introducing area was switched.

**Security and Anti-Poaching Efforts**
The threat from poaching remains, after conservation efforts increased the population of black rhino in Zimbabwe, poaching has now returned and is causing a decline in rhino numbers, offsetting all the recent gains in population (figure 5). Work on Serengeti anti-poaching elements began over two years ago. The aim is to increase protection around the Serengeti National Park and surrounding communities. The core of this effort was in training all Serengeti National Park rangers on Rhino protection. But additional effort was made in the creation of the elite rhino task force. These are the people on the front lines, protecting the rhino. This elite force received extra training in rhino protection. Multiple six-week long training sessions have trained 149 Serengeti rangers to get them all up to standard (Hartstone 2010). For instance they were taught live-firearm use, which before only some rangers had, some didn't. Out of this group a further 60 received further training to try out for the Serengeti Rhino Protection Unit (SRPU), of which 30 were accepted. The Elite training gets commando, and includes helicopter jump, small arms, and bush survival skills. In addition to releasing snared animals etc. All of this is crucial capacity building to protect the new population of rhinos.

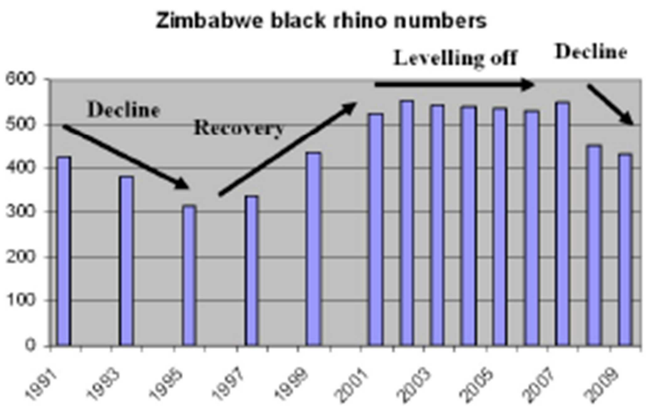



**Figure 5:** **Black rhino numbers in Zimbabwe showing the impact of increased poaching** (Milliken *et al* 2009).

Another crucial aspect to the permanent protection of these (and other) rhino, is to work with local communities to educate them about the value of rhino. Until infrastructure improves, poachers usually come from the surrounding communities, and it is a huge incentive, with large payouts for horn equal to many years normal work. Working with these communities on alternative sources of income and on the value of rhino is essential to cut off the source of poachers as it were. The rhinos have to become economically relevant to local communities, beyond horns (du Toit *et al* 2006). Beyond the more obvious eco-tourism (whose local community benefits are debatable), and conservation payment-schemes, I cannot find any other strategies for turning rhinos into a cash cow as it were. An area of understanding crying out for further research.

**The Introduction**
As of yet there are no journal papers on the release methodology, the below summary is cobbled from FZS and USFWS releases and articles. The rhinos arrived on May 21, 2010 – touching down at 4pm local time from their Hercules C-130 cargo aircraft plane from South Africa. The plane on a small airstrip in Seronera in the Serengeti National Park.
Prior to flight in South Africa, the rhinos to be moved were kept in bomas (enclosures) for about a month and a half to get used to the transport crates. In addition to all the logistical aspects, the transference had to adhere to CITES regulations as well as Tanzanian and South African veterinary requirements.
After the arrival, the rhino were then transferred to a remote compound, where they were released into bomas. The rhinos remained in the bomas to get acclimatized to the new

vegetation/food type (and occasionally supplementarily fed as needed). During this time the rhinos were also fitted with radio transmitters. Not the bulky round the neck types of yesteryear, but implanted into their horns. The rhino were also vaccinated against trypanosomiasis (vertebrate sleeping sickness). Following the two-week adjustment period in the bomas, the new arrivals were released into a larger temporarily fenced in area, where they remained for a few weeks. This is to prevent the rhino from bolting. The rhino were finally released on July 30, 2010. As you would expect though, they are closely monitored and guarded.

According to the initial reports three male and three female rhinos, between 3 and 16 years old, were on this first flight. However, it is not clear whether there were actually five or six rhino in that initial group, as reports say both numbers. A request to the PR department of FZS went unanswered. What I fear may have happened is that six rhino arrived and during acclimatization one died leaving five to be released, but this is conjecture.

**Post Reintroduction Monitoring and Future Releases**

The re-introduced rhino will be intensely monitored, facilitated by the radio-transmitters. As with all restoration projects, post-completion monitoring (and additional adjustments as needed) is crucial. For this project, luckily the post-introduction monitoring of the re-introduced rhino is well thought-out and structured with adequate resources. The rhino can be easily found at any time with radio tags.

As of now it is unknown when the next set of rhinos will be flown up from South Africa. Unfortunately I did not hear back from FZS on this. However it is likely that the team is monitoring the newly released rhino to make sure all is well, and whether the methods used to move and acclimatize the animals need tweaking.

## Serengeti Reintroduction & other Reintroductions

In reviewing the Serengeti project planning and methodology against other FZS black rhino re-introductions, such as in Luangwa, Zambia (Van der Westhuizen 2006) and against the general IUCN black rhino re-introduction guidelines the main activities were very similar (appendix 1). The elements of security capacity building, stock selection, pre-transfer acclimatization, transfer method (and sedation), arrival and post-travel boma acclimatization, and tagging are all very similar. However there are some areas where Serengeti differs.

The first is one site selection, rather than just using historic ranges (as in the case of Luangwa), or just evaluating the release area environmental factors, soil vegetation, etc (Emslie *et al* 2009). This project combined them in multifactoral modeling, including poaching risk that picked a site where there are no current rhino. Should such predictive modeling prove successful, it will be a great addition to rhino transfer strategy.

This is the largest system that black rhino have ever been introduced into, posing a problem of security and monitoring over such a vast, open range (unlike Luangwa which is fenced).

All the reintroduced animals come from a single population, the guidelines (Emslie *et al* 2009) recommend that re-introduced rhino be from different populations of the subspecies. Thus a further reintroduction of *D. b. michaeli* from another population or connection to the other Serengeti population would be advised, to enhance the genetic vigor of the metapopulations.

Another area of difference from other projects is the release method. In other projects, the rhino is released from a crate, while still drugged, all equipment is moved away, and only then is the rhino given the antidote by a single ranger who walks away. This method seems to be less stressful for the rhino, as they start feeding upon awakening, rather than charging cars and crates etc. (Emslie *et al* 2009). It's not clear why this was similar method was not followed in the Serengeti project.

The effectiveness of local community engagement is key, and how, again, due to the park's size this will be accomplished is unknown, as it is on a much larger scale, especially as the rhino will likely never bee seen by many of the local people (Van der Westhuizen 2006).

## The Future of Restored Rhino in the Serengeti

Metzger *et al* (2007) gives the target population for conservation for the Serengeti at 500. They acknowledge that this is an approximation, and that the rhino would not be evenly dispersed, rather concentrated at the denser vegetation areas of the park. The most suitable habitats for the rhinoceros were the Croton thickets of the north and the riverine forests of the north and west. These same habitats have been identified as preferred by rhinoceroses in Masai Mara National Reserve in Kenya (Dublin, 1995; Walpole et al., 2004). These preferred habitats span the Kenya–Tanzania border. Therefore trans-border cooperation will also be necessary for ongoing rhinoceros security (Metzger *et al* 2007, Thirgood *et al* 2005).

To establish and maintain rapid population growth rates and prevent potential habitat damage if the population overshoots carrying capacity, populations of black rhinos should be managed at densities below long-term ecological carrying capacity (Fyumagwa and Nyahongo 2010), perhaps at 75% (Emslie et al 2009), at least in the short-term.

I cannot find information on whether there will be any study on the impact of the rhino on the local ecosystem. Perhaps with an initial sub-population of 32 the impact will be negligible. But that is not a certainty. Additionally, as the population (hopefully) grows, the longer-lasting effects of reintroducing a large herbivore into the Serengeti system is not to be sniffed at. It is known that the area had the carrying capacity for at least 700 rhino (Frame 1980). In a dynamically balanced ecosystem such as savanna, where the constant war between trees and grass for coverage is refereed by disturbances such as fire and herbivory (Grese pers comm), the addition of a large herbivore could dramatically alter this balance on a large scale. As an example the eradication of the ungulate disease rinderpest, completely altered savanna ecosystem functioning; antelope exploded, lions (*Panthera leo*) increased, wild dogs (*Lycaon pictus*) decreased and the grass species community was altered (Van Langevelde *et al* 2003). Black rhino do exert uneven herbivore pressure on plants (Luske *et al* 2009). Other studies have shown that mega herbivores, due to their considerable biomass, play an important role in ecosystem structure (Cowling *et al* 2005), and at high densities can degrade the environment (Emslie *et al* 2009). How will black rhino browsing alter the plant community in the expansive Serengeti?

Beyond the direct effect on plant communities, there could be other effects of predator switching to rhino, thus releasing other prey species, alternatively, the presence of rhino may drive certain predators off. Parasites and disease transference could all be affected by the density of rhinos. Furthermore, it is unknown how the rhino will affect soils through compaction, or from nutrient (and seed) transfer through their feces, or from their interactions with other herbivores, etc. It is unknown how black rhino will alter ecosystem dynamics, trophic interactions, and community structure. The list of possible knock-on effects on the ecosystem of rhinos coming back into the Serengeti is endless, and ripe for research (gimme $ and I'll be first in line for this research!).

Bearing that in mind, though the reintroduction area is ideal under current conditions, after reintroduction, the conditions and threats will change and these changes should be anticipated. Long-term planning will need to include frequent reevaluation of poaching risk and commitment from government agencies, non-government organizations, and private stakeholders to provide the funding necessary to protect rhinoceroses. This includes building intelligence networks against poaching and illegal rhino horn trade. Likewise, the effects of rhino on ecosystem functioning should also be recorded, to allow for adaptive management strategies.

Key to their survival and persistence is to develop revenue streams from sustainable use of rhinos to offset the high conservation and monitoring cost.

The key to the success of these rhino is the involvement and buy-in by local communities. Through eco-tourism, biodiversity payments and other schemes, making the rhino worth more alive, and to more people than dead, then community-based activities promote rhino survival.

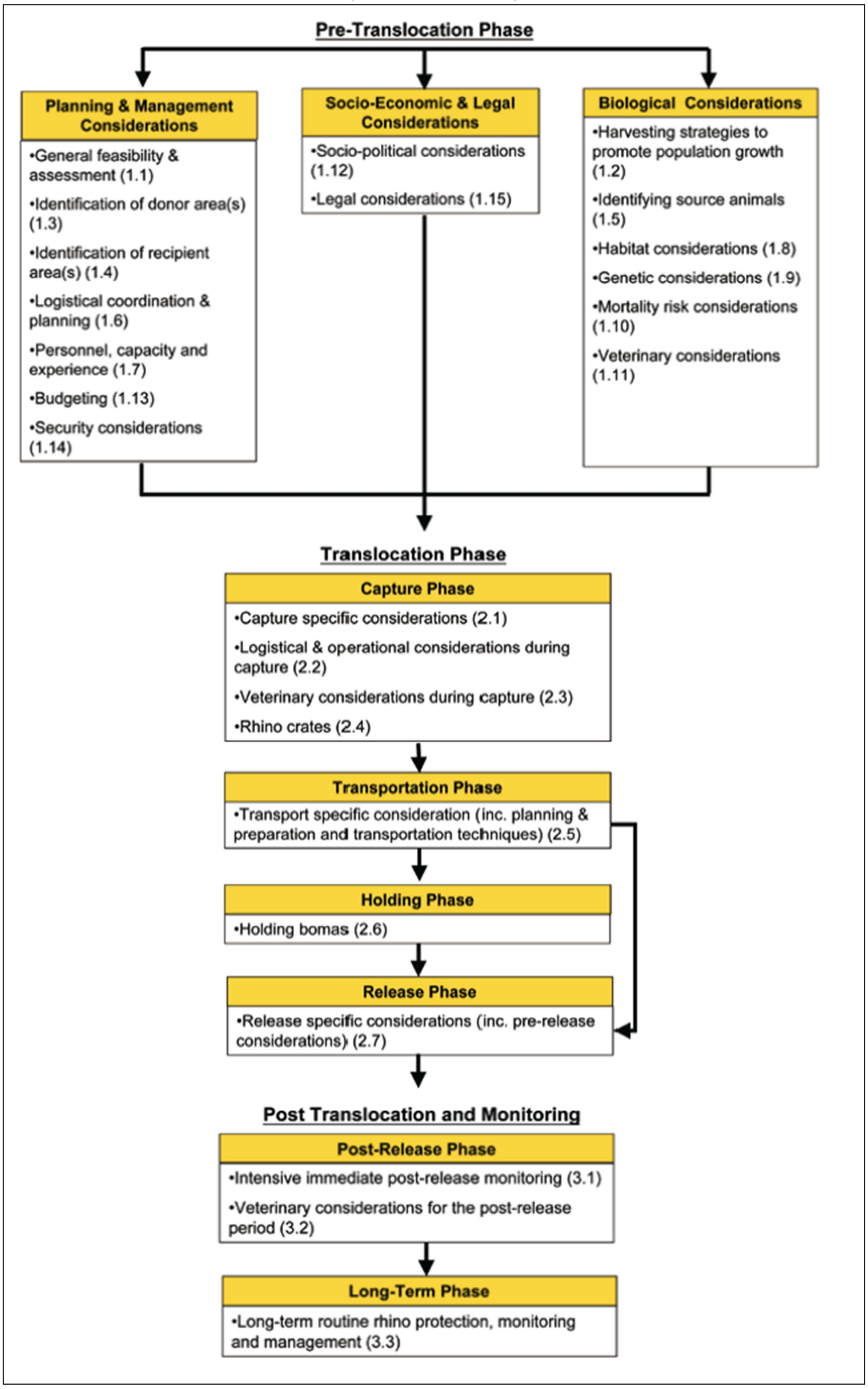
The IUCN rhino reintroduction guidelines are dense covering nearly 200 pages. This review was aimed not a step-by-step summary of how to re-introduce a rhino per the guidelines, rather it attempted to capture the mayor motivations, themes and challenges surrounding rhino reintroduction, but we've very much just scratched the surface.

In summary, how rock-on is it that they were able to pull this off! Recent improvements in rhino population numbers prove that rhinos can be conserved in the wild. The greatest challenge for the future of rhinos is maintaining sufficient conservation expenditure in the range states. If the post-reintroduction resources, management and activities continue, the future is bright for the eastern black rhino, in Tanzania.

# Appendix 1

## IUCN Rhino Specialist Group Phases of Rhino Reintroduction

(Emslie *et al* 2009)



# Appendix 2

## Black Rhino Habitat Suitability Model Inputs

(Metzger *et al* 2007)

| Study / Variable | Summary/Outputs | Actions/Methods | Manipulated Outputs |
|---|---|---|---|
| **Historic Records** | | | |
| 1969-1972 Serengeti Ecological Monitoring Programme - 31 monthly aerial (100m) reconnaissances. | Weighted mean Population size & density was extrapolated for the SNP | Sighting were corrected for unseen rhino's due to vegetation by aerially surveying an area with a known rhino population. 50% rhinos detected from aerial survey. | Further analyses refined the correction factor, leaving correction factor of 66% for the transect and 27% for the total count. |
| 1970 Buffalo Elephant and Rhino aerial survey of SNP | | | |
| Transect data from aerial antelope surveys | Extrapolated antelope hunting pressure to potential rhino poaching | Used antelope offtake to estimate hunting pressure | |
| **Independent Variables** | | | |
| Precipitation | Forty years of rainfall data from 58 gauges across the ecosystem | PPTMAP model used to create mean monthly and annual precipitation | Data corrected for elevation |
| Permanent Water - Rhinos need daily access to water | GIS blending of 55 national hydrological maps | Permanent water sources identified and distance to water grid-cell map created. | |
| Elevation & Site Severity | Slope and aspect were integrated into GIS | Determines solar radiation and moisture | Possible predictor of habitat preference for large animals |
| Vegetative Map | Vegetative-type cover determined using Landsat 7 data from one day in 2000 | Extensive field verification | Integrated variables include most frequent vegetative class, variation per area & % canopy coverage |
| **Poaching Risk** | | | |
| Poaching risk depends on probability of rhino encountering illegal hunters | Locations where hunters were originating from, and how far they travelled were determined (arrest data). Poaching/kill locations identified. Number of hunters per population estimated | Hunting mortality rate derived from antelope off take rate and rate of population change | |

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