When less is more: Adapting Black Rhino conservation targets in response to long-term ecological and population data

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Introduction

The black rhinoceros, *Diceros bicornis*, is currently listed on the IUCN red list as critically endangered, with the global population estimated at 5,040-5,458 individuals (Emslie et al., 2016). Majority of these animals reside on protected areas that have a high level of security and patrol effort and rely on government, private and community support, and scientific research to thrive (Amin et al., 2006; KWS 2016). The eastern Black rhinoceros subspecies (*D. b. michaeli*) has fewer than 800 individuals across Africa and has been the focus of intensive conservation efforts continent-wide. In Kenya, the government, primarily through the Kenya Wildlife Service, mainly drive these conservation efforts through a public-private partnership with private and community owned conservancies.

On Lewa and Borana conservancies in Kenya, which are co-managed as one landscape, there are a total of 87 black rhino. This population was first introduced in 1984 when a portion of the landscape was set aside as a rhino sanctuary with a founder population of 15 black rhino, before the current conservancy was established in 1995. Since then, the population has expanded remarkably, both through translocations in as well as natural births. Lewa is especially unique among Kenya rhino sanctuaries by not having experienced any successful poaching events over the last five years. This is as a direct result of intensive ecological management, investment in state of the art security technology, and invaluable goodwill from surrounding communities.

While this black rhino population has been intensively managed for the last 30 years, and the population is encouragingly at an all-time high, the long-term population performance had not been analysed in its historical entirety prior to 2017. As such, population performance metrics and their relative changes over time, especially in response to reduced browse availability, were as yet undetermined. In 2017, the Lewa-Borana Research department collaborated with Keryn Adcock, a member of the African Rhino Specialist Group (AfRSG) to collate and interpret long-term data collected on the Lewa portion of the Landscape, which holds 62 of the LBL's 87 black rhino. The goal of this exercise was to facilitate better visualization and analysis of long-term Black rhino performance on Lewa, identifying important trends and discussing possible ways to further enhance the Lewa-Borana Black rhino management strategy.

Materials and Methods

Individual life statistics data were collated from all black rhino to ever be born, die, or be translocated into or out of Lewa since 1984. All births, deaths, and translocation events were confirmed through hand written records and rhino databases.

All raw data was fed into a proprietary automated excel-based workbook that was set up by Keryn Adcock. This workbook system is set up to automatically calculate age at first calving, inter-calving intervals, underlying biological growth rates, actual growth rates, sex ratios, as well as overall population structures. The interactive nature of the system allows different datasets to be included or excluded. As such, we were able to look at life tables under different scenarios, including with translocations in or out of the population excluded.

Growth rates were calculated as three year moving windows to account for spikes and troughs occasioned by time offsets from the prolonged gestation periods in black rhino and variations in breeding related to good or bad rainfall years. To calculate biological growth rates, human induced mortalities were treated as removals, while actual growth rates were calculated with human induced mortalities included. For simplicity, here we only present data from the last 17 years.

Results and Discussion

In general, the Lewa black rhino population exhibited increasing numbers and population growth rates before reaching a peak between 2004-2006. Thereafter, while overall numbers remained high, the population exhibited lower growth rates over time. Our analysis of these observations in combination with knowledge of management interventions across the same period allowed us to develop three distinct phase classifications that sought to contextualize these trends.

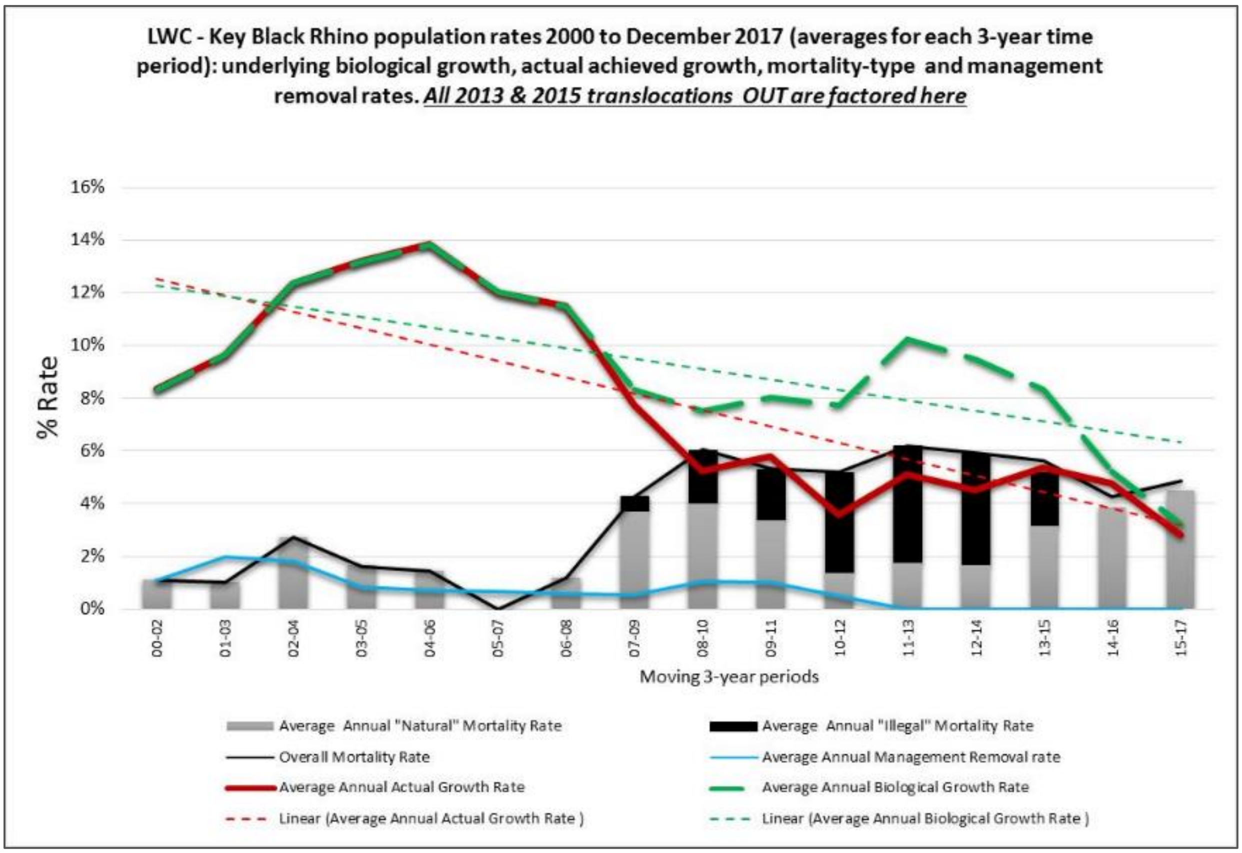

Figure 1: Graph showing key black rhino population rates as at January 2000 to December 2017

Phase one; between 2000 and 2007 the conservancy recorded rapid population growth as low population meant there was surplus browse for the black rhino species. Maintaining a lower population size and increasing browse availability has been shown to have a positive effect on rhino population growth, especially in enclosed sanctuaries (Adcock & Elmslie, 2003; Adcock 2004).

Phase two; between 2008 to 2013, Lewa experienced reduced growth rate due to human induced and natural mortalities. During this period, drought played a major role in reducing browse availability for rhino and increasing competition as other mega herbivores like elephants moved into Lewa. Deficiencies in browse availability can reduce rhino productivity as well as induce calf mortalities due to insufficient nutrition to calves from the mothers (Muya & Oguge 2000). At the peak of this period, poaching was a major problem, further reducing the actual growth rates through to the end of 2012-2013 (Fig. 1).

Phase three; between 2013 and 2017. After human induced mortalities were eliminated, management interventions to move out rhino came into place. In 2013, 11 individuals were moved to Borana Conservancy, which is co-managed as a single contiguous landscape with Lewa. In 2015 nine individuals were translocated to Sera Community Conservancy. These translocations only minimally enhanced the overall growth rates, and this was exacerbated by natural mortalities through to the end of the period in focus. In the most recent three-year rolling period, between 2015 and 2017, the average annual biological growth rate was about 1% while the average annual mortality rate stood at 6.2%, with natural deaths being the main causes for the low growth rate during this period.

We further conducted a comparative analysis to find out if the population performance would have been significantly different if translocations out had not happened, and all other factors remained constant. The findings show that between 2013 – 2017, the average biological growth rate would have only been enhanced minimally in each 3-year moving average if translocations had not taken place (Table 1).

This analysis clearly shows that the downward trend in population growth rates would have continued even without human intervention. In the absence of other confounding factors like disease and predation, this slow-down in growth rate is most easily explained by nutrition or density-dependent reductions in fecundity. A large part of this probable nutrition stress can be attributed to the less than ideal rainfall conditions experienced across the landscape during this period.

Table 1 - Comparison of *actual* and *biological* growth rates with and without rhinos that were translocated OUT of Lewa in 2013 and 2015

	Moving 3-year windows		
	13-15	**14-16**	**15-17**
Average annual actual growth rate *(rhinos translocated OUT in 2013 & 2015 are excluded here)*	4.7%	3.3%	1%
Average annual actual growth rate *(rhinos translocated OUT in 2013 & 2015 are included here)*	5.4%	4.8%	2.8%
Average annual biological growth rate *(rhinos translocated OUT in 2013 & 2015 are excluded here)*	8.2%	3.9%	1.1%
Average annual biological growth rate *(rhinos translocated OUT in 2013 & 2015 are included here)*	8.3%	5.2%	3.2%

Much of the low growth, however, is likely tied to the fact that Lewa has effectively reached its estimated Ecological Carrying Capacity (ECC). Figures from 2006 estimated the ECC to be 70 animals. Currently, the conservancy is occupied by 62 animals; close to this original ECC estimate. However, social pressures always set in even before the ECC is explicitly achieved. Furthermore, these figures assume a static forage base, and the Lewa landscape has experienced a significant reduction in woody vegetation over the last 20 years.

Most instructively, *Acacia drepanolobium*, which constitutes 63% of the black rhino diet on Lewa (L. Jackson, unpublished report), has seen a 5.6% reduction in cover over the last 38 years (Giesen et al., 2017). This decrease in the density and cover of woody vegetation has been attributed to an increase in megaherbivore populations and varying precipitation patterns. In addition, erratic rainfall and the general reduction of other preferred black rhino browse makes it likely that the current ECC is lower than historical estimates, and that the Lewa population has already surpassed the actual current upper density limit. Previous studies have established that in enclosed populations with low mortality rates, markers of productivity like age at first calving and inter-calving intervals tend to be density-dependent (Rachlow & Berger 1998; Law et al., 2013). In addition to impacts on nutrition and calf survival, increased densities also have an impact on social behaviour, including through increased territorial conflicts, which can affect breeding and calf rearing.

Conclusion and implications for conservation

The reduction in growth rates of the Lewa black rhino population following successful achievement of high densities closely parallels trends observed in other enclosed or small rhino sanctuaries, and these sanctuaries offer insights into the best interventions to halt and reverse these trends. The most immediately available solution is to reduce the density of black rhino on Lewa. This can be achieved through translocation to other sink sanctuaries and has been done on Lewa in the past, in close collaboration with the Kenya Wildlife Service and other partners. The improvement in population growth post translocation is likely to reduce over time and therefore, continuous translocation out is encouraged. Lewa therefore needs to focus efforts on supporting development of suitable new black rhino range or expansion of current black rhino habitat.

This strategy would allow a set offtake to be established for the resident population, which would likely lead to a commensurate response in growth rate. By focusing on annual growth rate as opposed to overall rhino numbers as a population productivity marker, management would be able to both maintain the health of Lewa’s black rhino population as well as provide source animals for new or expanded sanctuaries across Kenya. This would support Kenya’s black rhino management strategy and contribute significantly to increasing Africa’s black rhino population, helping push this iconic species further away from extinction.

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