Ceratotherium simum simum – Southern White Rhinoceros


Geoffrey Oddie

Regional Red List status (2016)	**Near Threatened A4ad*†**
National Red List status (2004)	Least Concern
Reasons for change	Genuine change: Declining population
Global Red List status (2011)	Near Threatened C1+A3ad
TOPS listing (NEMBA) (2007)	Protected
CITES listing (2005)	Appendix II in South Africa and Swaziland (Appendix I in all other countries)
Endemic	Near
Proportion of global wild population conserved in South Africa and Swaziland at end of 2015	91%

*Watch-list Threat †Conservation Dependent

White Rhino subpopulations are being hard hit by criminal trafficking syndicates, especially in the Kruger National Park. Combatting the poaching crisis requires a multifaceted strategy including anti-poaching programmes, demand reduction campaigns, disrupting criminal networks and providing options for alternative economies in areas abutting protected areas (Ferreira et al. 2015).

Taxonomy

Ceratotherium simim simum (Burchell 1817)

ANIMALIA - CHORDATA - MAMMALIA - PERISSODACTYLA - RHINOCEROTIDAE - *Ceratotherium – simum – simum*

Common names: Southern White Rhinoceros, Southern Square-lipped Rhinoceros (English), Witrenoster (Afrikaans), Umkhombo Omhlophe (Ndebele), T'shukudu, Mogohu (Sepedi), Tshukudu, Mogohu, Tshukudi e Molomo o Sephara (Sesotho), Kgêtlwa, Tshukudu, Mogôhu (Setswana), Chipembere (Shona), Umkhombe (Swati, Xhosa), Tshugulu (Tshivenda), Mhelembe (Xitsonga), Ubhejane Omhlophe (Zulu)

Taxonomic status: Subspecies

Taxonomic notes: While some researchers have proposed species status for both Northern (*Ceratotherium simum cottoni*) and Southern White Rhinoceros (hereafter White Rhino; *Ceratotherium simum simum*) (Groves et al. 2010), subspecies status was supported following comparison of whole mitochondrial genome sequences of Northern and Southern White Rhino (Harley et al. 2016). This work concluded that it is possible that the two White Rhinoceros lineages could have diverged as recently as 200,000 years ago. Oliver Ryder (pers. comm. 2016) at San Diego Zoo independently reached a similar conclusion on the species/subspecies issue as Harley et al. (2016) based on his own genetic research. Harley et al. (2016) were also critical of the use of the phylogenetic species approach to defining species taken by Groves et al. (2010). The IUCN SSC African Rhino Specialist Group continues to treat the two taxa as subspecies rather than separate species.

Assessment Rationale

The White Rhino was brought back from the brink of extinction due to colonial overhunting and clearing of land for agriculture with only an estimated 20–50 animals left in 1895. These survived in one population in the Umfolozi area of what today is Hluhluwe-iMfolozi Park in KwaZulu-Natal (KZN), South Africa. Umfolozi was proclaimed as one of Africa's first Game Reserves in part to conserve the last few remaining White Rhino living there. Under protection, numbers increased, though by 1960 all remaining White Rhino still occurred in only one population. However, following the development of immobilisation and translocation techniques in the 1960s by the then Natal Parks Board, the process of re-establishing subpopulations of White Rhino into its former range began in 1961 with animals also being moved to zoos and safari parks worldwide. This combination of protection and biological management (translocations to keep established subpopulations productive whilst creating additional new subpopulations with the potential for growth) resulted in a rapid increase in numbers of White Rhino subpopulations, including those on private land and in former range states throughout Africa, such as Swaziland during the early 1980s. Regionally and continentally numbers continued to increase between 1992 and 2010. However, since 2008, increased poaching and the growing involvement of transnational organised crime networks have decelerated growth in numbers at a continental level, which represents an emerging threat to this subspecies. Estimated total White Rhino numbers in Africa showed a 0.4% / annum decline from 2012–15, although this was not statistically significant and within the margin of error around count estimates.

Recommended citation: Emslie R, Adcock K. 2016. A conservation assessment of *Ceratotherium simum simum*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

In recent years, South Africa as the major range state, and Kruger National Park (KNP) in particular, has borne the brunt of the White Rhino poaching. Figure 1 and Table 2 provides details of regional White Rhino poaching over the last six years (May–April). Encouragingly in 2015, poaching in South Africa declined for the first time since 2008 (Table 2). Current successful protection efforts in both South Africa and Swaziland have depended on significant range state expenditure and effort. Declining state budgets for conservation in real terms, declining capacity in some areas, rapidly escalating security costs and risks, declining economic incentives and increasing involvement of transnational organised crime in poaching and trafficking are all of concern.

Red List modelling for this assessment examined what would happen under a range of poaching and underlying growth scenarios. For a detailed description and rationale behind the approaches taken see the Black Rhinoceros (hereafter Black Rhino; *Diceros bicornis*) assessment (Emslie & Adock 2016). Given the high levels of poaching, increasing disposable income in Southeast Asian consumer countries, and the fact that, in the absence of existing conservation measures, the subspecies would probably quickly decline, it is justified for the White Rhino to be listed as Near Threatened A4ad as a genuine uplisting within the assessment region. Rhino population estimates are revised by IUCN SSC African Rhino Specialist Group (AfRSG) every 2–3 years with surveys of the status of White Rhino on private land every few years. It is planned to move to a system of annual status reporting in South Africa. This assessment will thus be revised regularly to monitor the impacts of poaching.

Key interventions for this subspecies include enhanced protection efforts and enforcement of penalties combined with ongoing range expansion and reintroduction in the short-term, combined with demand reduction campaigns in the long-term. In parallel, there is a need to integrate and involve local communities more in the conservation effort and associated benefits; increase economic incentives for rhino ownership; and find ways to sustainably fund conservation efforts and associated benefits. White Rhino remain conservation dependent due to the immediacy of mitigating the poaching threat and because many subpopulations are restricted to small, fenced reserves or wildlife ranches, necessitating active translocation to conserve genetic diversity.

Regional population effects: South Africa remains the stronghold of the White Rhino population and thus no significant rescue effects are anticipated. If South African and Swaziland populations were to decline significantly, a similar trend would be expected in other range states and thus unlikely to be in a position where they would have surplus rhinos available for restocking.

Distribution

The White Rhino is now the most numerous of the rhino taxa, having ranged from Morocco to South Africa in the Pleistocene (Skinner & Chimimba 2005), with South Africa remaining the stronghold for this subspecies despite increased poaching. Sizeable populations occur in the greater KNP (which incorporates adjacent private and state reserves) and Hluhluwe-iMfolozi Park in KZN, but also occur in numerous state-protected areas and private reserves throughout the country. For the latest numbers by country see Emslie et al. (2016). At the end of 2015, South Africa and Swaziland conserved 90.7% of the continent's White Rhino, an estimated 18,413 and 76 individuals respectively out of a total of 20,378. Live sales, limited sport hunting and ecotourism have historically provided incentives that helped encourage a significant expansion of range and numbers on private land in South Africa. The private sector in South Africa now conserves more White Rhino than there are Black and White Rhinos in the whole of the rest of Africa. By the end of 2015, a third of South Africa's White Rhino (~ 6,140) were conserved on private land. However, increased poaching, increased security costs, increasing numbers of incidents deemed threatening to human life, and perceived reduced incentives for their conservation, have resulted in reduced White Rhino live sale prices and an increasing number of owners seeking to remove their rhino. This worrying trend threatens to reverse the expansion of range and has the potential to significantly reduce conservation budgets (due to declining live sales), and possibly negatively affect metapopulation growth rates in future.

There are smaller reintroduced populations within the historical range of the species in Namibia, Botswana, Zimbabwe and Swaziland, while a small number that crossed from KNP currently survive in Mozambique (after existing reintroduced populations had been poached out). Populations of White Rhino have also been introduced outside of the known former range of the subspecies to Kenya, Uganda and Zambia (Emslie & Brooks 1999; Emslie et al. 2007). Uganda was previously a Northern White Rhino range state and so the subspecies has been reintroduced to this country as the indigenous Northern White Rhino subspecies was not available for reintroduction. Similarly, in Kenya, paleontological evidence indicates the country once historically conserved White Rhino and the southern subspecies has therefore been reintroduced into the country.

Note: At the request of certain rhino owners, managers and range states, the IUCN SSC African Rhino Specialist Group (AfRSG) has a policy of not releasing detailed information or maps on the whereabouts and sizes of rhino subpopulations for security reasons.

Population

Once widespread in the bushveld areas of southern Africa south of the Zambezi river, the White Rhino was on the brink of extinction by the end of the 19th century (*c*. 1895) having been reduced to just one small population of approximately 20–50 animals in KZN, after settlers had over-hunted them for sport and to clear land for agriculture throughout almost all of their historical range (Emslie et al. 2009). By the end of 2015, after years of

Table 1. Countries of occurrence within southern Africa

Country	Presence	Origin
Botswana	Extant	Reintroduced
Lesotho	Absent	-
Mozambique	Extant	Re-established with cross-border movement from KNP.
Namibia	Extant	Native
South Africa	Extant	Native
Swaziland	Extant	Native
Zimbabwe	Extant	Native

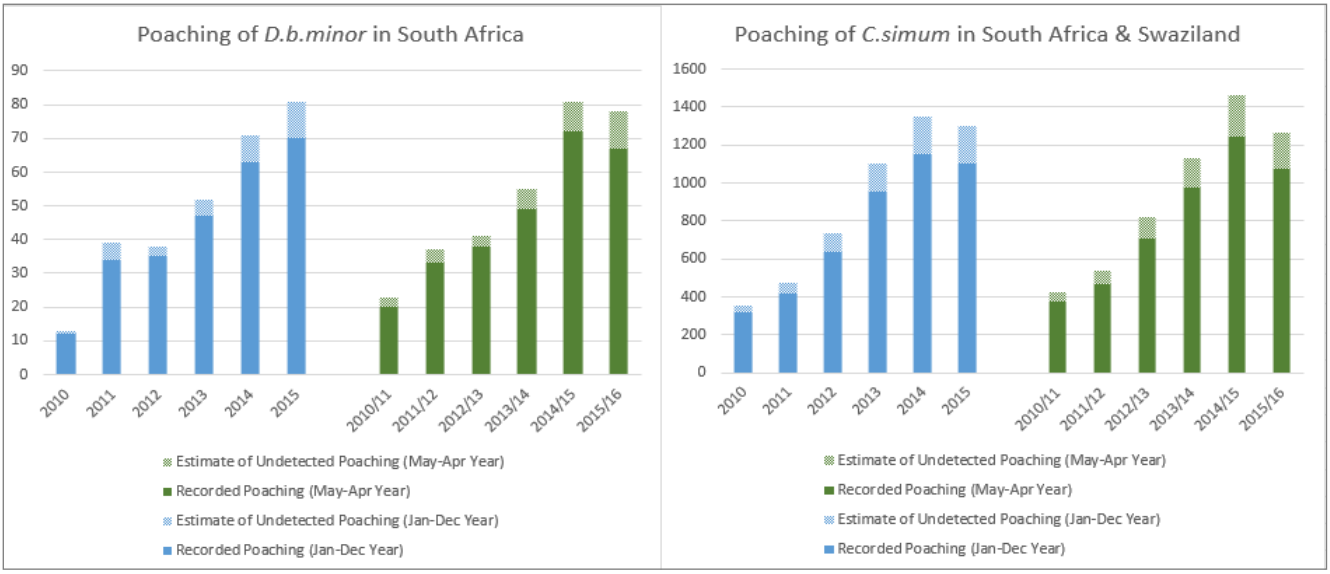

Figure 1. Reported poaching and estimates of undetected poaching of Black (left) and White Rhino (right) in the South Africa Swaziland Region summarised over calendar years (blue), as well as years from May to April (green). Since 2010, only three White Rhino[1] and no Black Rhino have been poached in Swaziland. All Black Rhino poached in the region up to the end of 2014 were *D. b. minor*, and it was assumed that this also applied to the Black Rhino poaching in the rest of South Africa over the 16 months Jan 2015–Apr 2016. At the time of assessment, a breakdown of the total reported rhino poached by species and subspecies for the same period was only available for some major but not all South African rhino populations. Where a species breakdown was not available, poaching was allocated to species on a pro rata basis based on past data going back to January 2010 for these areas[2]. Additional estimates for undetected poaching (lighter shaded areas at top of bars in graph) were based on the assumption that the rhino poaching detection rate in KNP was 80%.

protection and many translocations (Emslie & Brooks 1999), the subspecies had grown to 20,375 animals in the wild and semi-wild. Rampant poaching and the failure to enforce the law or pass adequate sentences resulted in Swaziland's population being reduced to 33 over the period 1987–93. However, changes to the law and very effective protection efforts by Swaziland's Big Game Parks since then successfully halted the poaching in the country with only three rhino being poached between 2006 and 2015, and numbers currently at 76 by end of 2015 (Emslie et al. 2016). South Africa remains the stronghold for this subspecies, conserving an estimated 18,413 individuals by the end of 2015 (Emslie et al. 2016). Since 2008, increased poaching and the emerging involvement of transnational organised crime networks has decelerated growth in numbers at a continental level (Emslie et al. 2016), and within the assessment region (Figure 1; Table 2).

Figure 2 shows how total numbers of White Rhino have increased since 1960 from an estimated 1,120 to 20,375 individuals by the end of 2015, but the opposite has happened to Northern White Rhino. Numbers of the latter were more common in 1960 with an estimated 2,230 in 1960 but have declined to currently number only three ex-zoo and non-breeding animals in a Kenyan reserve. The only way that any Northern White Rhino adaptive genes can be conserved will be through high-tech assisted reproduction techniques using semen and oocytes obtained from the remaining Northern White Rhinos. However, there are no guarantees this may be successful, and it is likely to take some time and be very expensive.

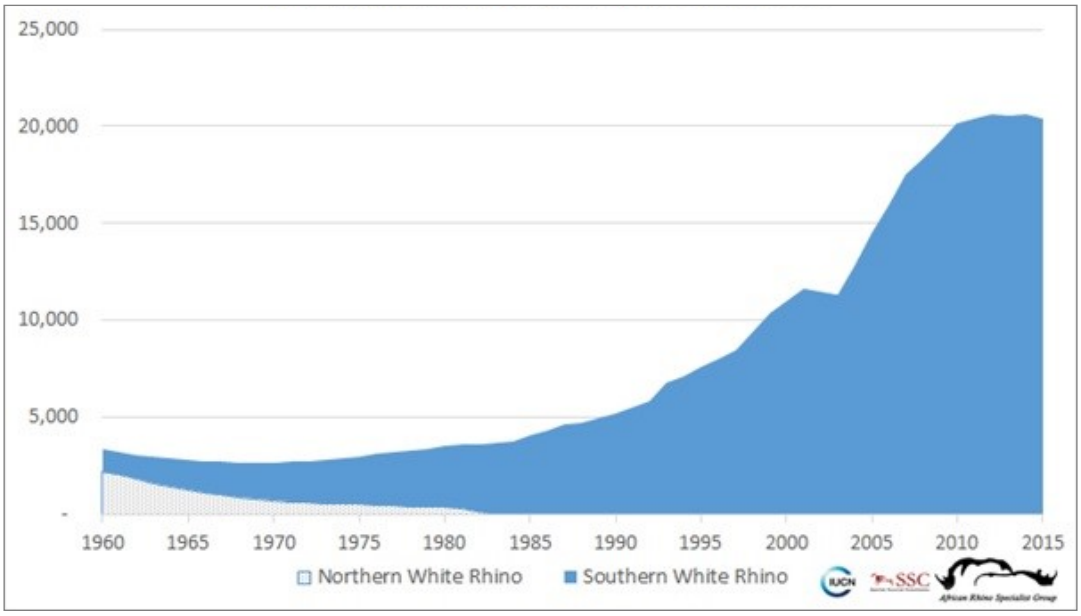

Figure 2. Estimated numbers of two White Rhino subspecies, *C. s. simum* (Southern White Rhino) and *C. s. cottoni* (Northern White Rhino) since 1960

Numbers of White Rhino under private ownership continues to increase, accounting for 33% of South Africa's White Rhino (~ 6,140 individuals) by the end of 2015. Two thirds of the White Rhino in the country continue to be conserved on state land. The largest subpopulation in the assessment region is in KNP, currently (2015) estimated at 8,875 individuals. After becoming extinct in KNP in 1896, the subspecies was reintroduced in the 1960s (Pienaar 1993) and grew at a rapid rate for many years until low levels of removals and resultant increasing densities saw a reduction in breeding performance in some areas of the park (S. Ferreira pers. comm. 2016). The escalation of poaching since 2008 has affected KNP especially hard given its large size and lower field ranger densities as well as its long shared border with Mozambique. A bootstrap analysis based on count results suggests there is a 92% chance that numbers of White Rhino have declined from 2012–2014 in KNP (R. Emslie unpubl. data). As a result of the escalation in poaching, South African National Parks (SANParks) increased removals, especially from vulnerable areas, and has set up an intensive protection zone (IPZ). Anti-poaching efforts have also increased with increased cooperation from law enforcement agencies, including the South African Police Service (SAPS) and the South African National Defence Force (SANDF) from a joint operations centre. Innovative technological solutions are also being increasingly developed to protect rhinos in KNP. In 2015, total numbers of White Rhinos recorded poached in the country and in KNP declined slightly for the first time since poaching started to escalate in 2008. However, there is no room for complacency as the number of incursions into KNP remains high. The total number of White Rhino in the region (South Africa, Swaziland and Lesotho) at the end of 2015 has been estimated by AfRSG at 18,489 individuals (Figure 3), with bootstrapped 90% confidence levels around the estimate from 17,836 to 19,156 (Emslie et al. 2016).

For the reasons outlined in the Black Rhino assessment, it was decided to use predicted numbers five years into the

Table 2. Estimated White (WR) and Black Rhino (BR) poaching in South Africa and Swaziland over the last six trailing twelve months (TTMs) together with derived arithmetic and exponential annual changes to apply based on poaching trends over the three periods looking back 1 (recent), 3 (intermediate) and 5 (longer) years. The tables include estimates for additional rhino poached if one assumes the rhino poaching detection rate in Kruger National Park (KNP) was 80%. Starting levels of poaching for Year 0 were set as the past level of poaching for the TTM May 2015–April 2016. The 1, 3 and 5 years refer to TTMs, not calendar years.

Period Start	Period End	Region WR	Region BR	Region WR	Region BR	Region WR	Region BR
		Numbers reported poached		Estimate for undetected poaching assuming 80% detection rate in KNP		Total estimate (reported + estimate for undetected poaching)	
May	April		(all *D. b. minor*)		(all *D. b. minor*)		(all *D. b. minor*)
2010	2011	375	20	46	3	421	23
2011	2012	470	33	69	4	539	37
2012	2013	705	37	113	3	818	40
2013	2014	977	49	155	6	1,132	55
2014	2015	1245	71	217	9	1,462	80
2015	2016	1076	67	186	11	1,262	78
Recent	1 year	-169.0	-4.0			-200.0	-2.0
Intermediate	3 years	123.7	10.0			148.0	12.7
Longer	5 years	140.2	9.4			168.2	11.0
Starting at Year 0						1,262.0	78.0

Period	Period	Region WR	Region BR	Region *D. b. min*	Region WR	Region BR	Region *D. b. min*
Start	End	% of estimated population reported poached / year (assuming all poaching detected)			% of estimated population poached / year (adjusted to include estimate for undetected poaching)		
May	April						
2010	2011	1.99	1.02	1.15	2.18	1.18	1.32
2011	2012	2.45	1.71	1.97	2.73	1.92	2.21
2012	2013	3.67	1.97	2.31	4.09	2.13	2.49
2013	2014	5.15	2.55	3.01	5.63	2.86	3.37
2014	2015	6.65	3.60	4.28	7.24	4.04	4.80
2015	2016	5.82	3.38	4.07	6.39	3.92	4.70
Recent	1 year	-12.49	-6.02	4.95	-11.79	-2.99	-1.91
Intermediate	3 years	16.36	19.68	20.51	15.92	21.81	22.61
Longer	5 years	24.89	24.17	25.44	24.63	24.42	25.66
Starting at Year 0					6.39	3.92	4.70

future in the Red List assessment. For illustrative purposes, population trends were also modelled up to ten years into the future. A range of poaching scenarios were modelled based on reported poaching trends over the last 1, 3 and 5 years (using trailing 12 months May to April in order to use the most up to date data available at the time of modelling). Average annual arithmetic and exponential changes (as a percentage of the population poached each year) were modelled based on assumptions that 100% and 80% of poaching mortalities were detected in KNP. A long-term average underlying growth rate of 7.7% (achieved over a period up to end 2007 just prior to the upsurge in poaching) was used in the modelling. For illustrative purposes, lower and higher underlying growth rates of 5% and 9% were also modelled. The results were graphed in relation to critical threshold levels under Criteria A4 and C1. For an explanation of how to interpret these graphs see the section on graphical display of predicted rhino numbers and Red List categories under Criteria A4 and C1 in the Black Rhino assessment

In the graphs, the star symbol represents the average results (arithmetic and exponential) for the three poaching periods for the given detection rate using only the best long-term estimate of underlying growth (7.7% / annum). The first three graphs (Figures 4–6) below show predictions based on an assumed 100% poaching detection rate modelling a continuation of poaching trends over the previous 5, 3 and 1 year TTM periods. The following three graphs (Figures 7–9) assume an 80% detection rate in KNP (given its vast size and lower field ranger densities).

The bottom row in Table 3 (averaging results across all three poaching periods modelled – effectively giving a greater weighting to more recent poaching trends) provides the best estimates of future numbers in five years used in this assessment. The modelled numbers show either a small total 1.9% projected increase over five years (if 100% detection in KNP) to a slight 3.9% total decline (if 80% detection in KNP).

The results (Figures 4–9 and Table 3) show that in no instances did numbers after 5 years drop enough to come close to any of the threshold levels under A4 and C1 to be rated in any of the threatened Red List categories (including for the most extreme poaching scenario modelled based on last 5-year poaching trends). The results also show how the slowing of the rate of increase in poaching and most recent slight decline in poaching has significant implications for future projected numbers if this recent progress can be maintained. For example, Table 3 shows that if the reduction in poaching over the last year can be maintained, White Rhino numbers in the

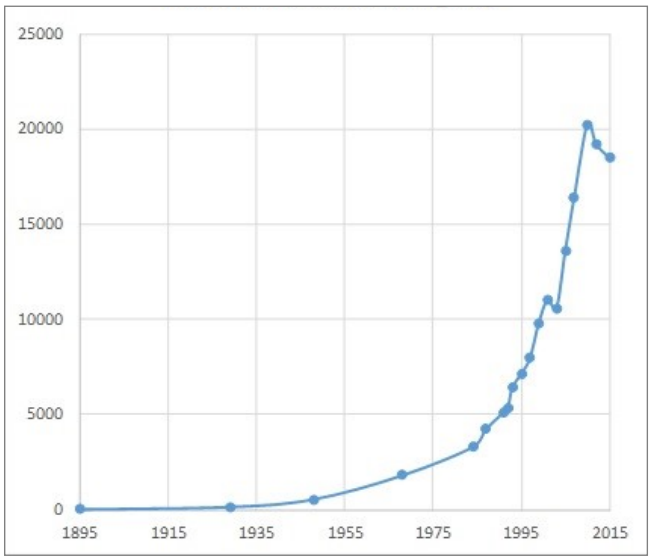

Figure 3. Population growth of Southern White Rhino (*C. simum simum*) in South Africa and Swaziland (excludes translocations out of the region)

region are projected to grow over the next 5 years: modelling trends based on 1 year's poaching trend resulted in numbers increasing even if only 80% of poached carcasses are being detected in KNP. Alternatively, if this proves to be a temporary improvement and poaching once again increases (as predicted based on previous 3- and 5-year trends), then White Rhino numbers will decline over the next 5 years. While numbers were projected to decline based on 3-year poaching trends, the projected declines were not as large as when modelling poaching trends over the last 5 years. The graphs show that only when projecting 10 years into the future, under the most extreme exponential poaching increases of just under +25% per annum (based on 5 year trends), did numbers decline enough for any of the modelled scenarios to cross the threatened criteria A3 and C1 thresholds, where numbers dipped into the Vulnerable (100% detection) or Endangered (80% detection) statuses.

Current population trend: Levelled off and possibly declining slightly.

Continuing decline in mature individuals: Possibly, if current progress in reducing poaching over the last year is not maintained.

Number of mature individuals in population: 10,274 at end of 2015, using a 55.8% mature population structure (Southern African Development Community Rhino Management Group; SADC RMG unpubl. data).

Table 3. Average results of modelling White Rhino numbers in South Africa and Swaziland using only best estimate of long-term underlying growth rate (7.7% / annum) and averaging models based on both arithmetic and exponential changes in poaching based on different time periods and averages across all three time periods modelled

	100% detection rate in KNP	80% detection rate in KNP
Starting number (end 2015)	18,489	18,489
End 2020 based on last 5 years' TTM poaching trend	16,277	14,775
End 2020 based on last 3 years' TTM poaching trend	17,485	16,124
End 2020 based on last year's TTM poaching trend	22,776	22,102
End 2020 based on averaging results with poaching modelled over last 5,3 and 1 year TTM periods (best estimates used in assessment)	18,846	17,767

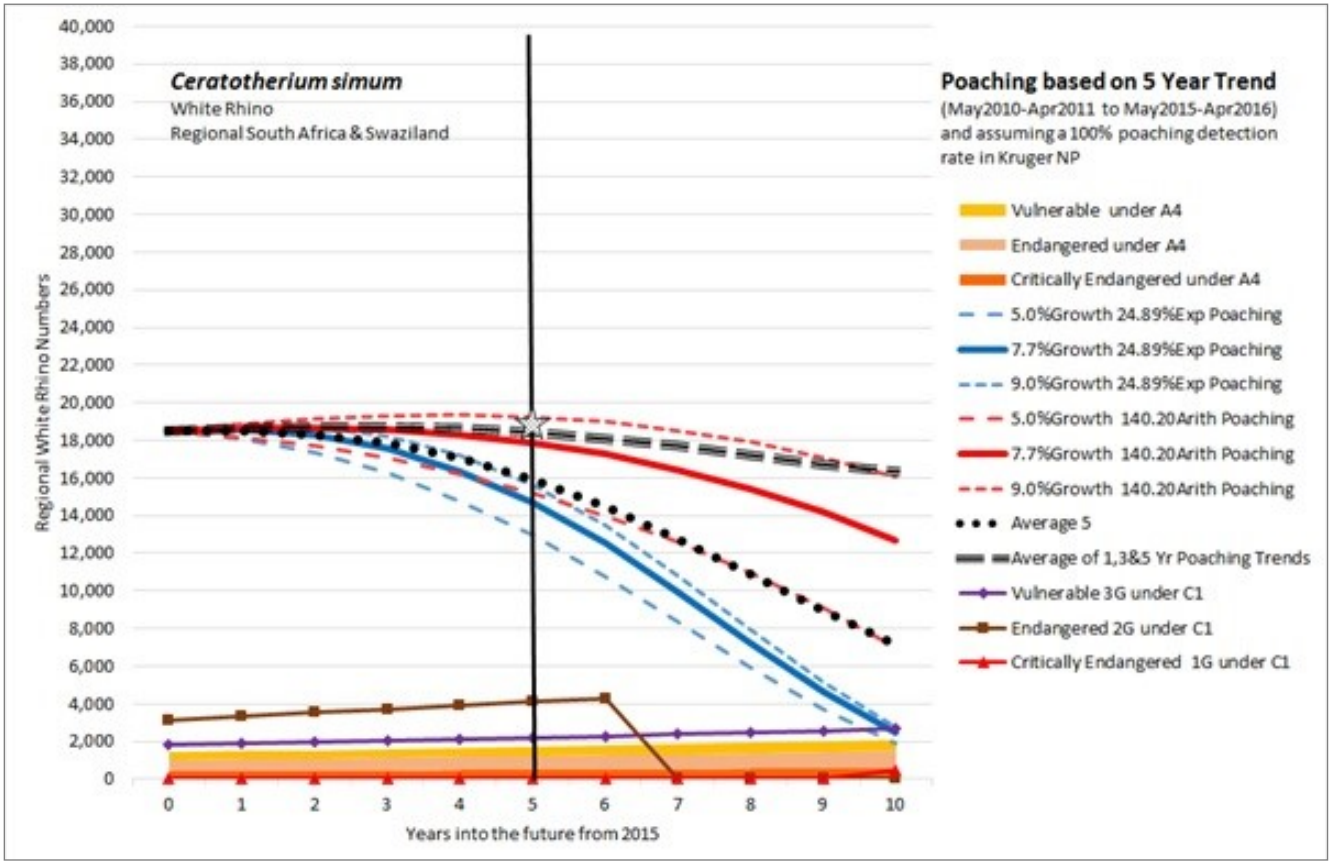

Figure 4. Modelling of total White Rhino numbers in the region based on the last 5-year (TTM May–April) poaching trend (assuming 100% detection rate in KNP)

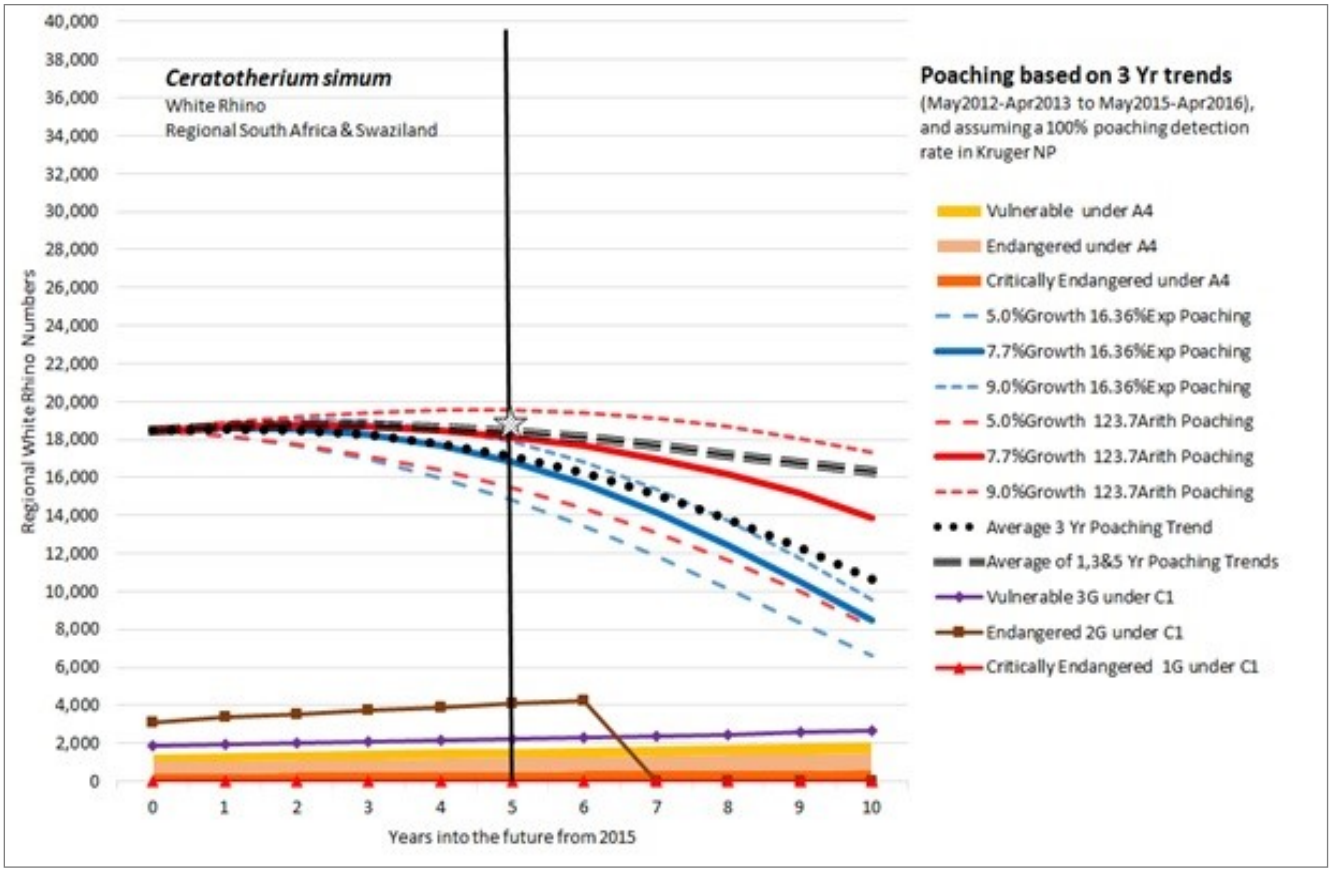

Figure 5. Modelling of total White Rhino numbers in the region based on the last three-year (TTM May–April) poaching trend (assuming 100% detection rate in KNP)

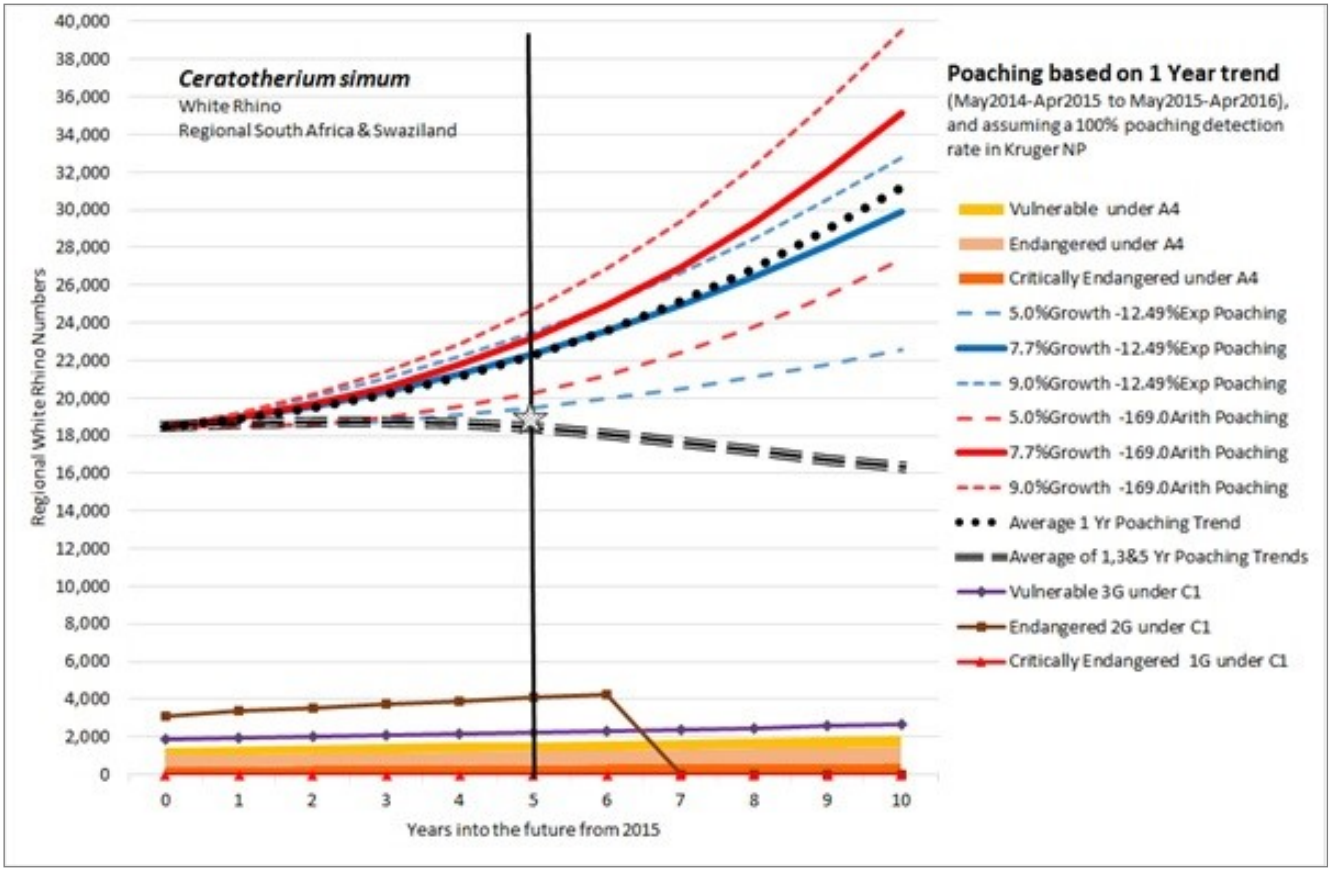

Figure 6. Modelling of total White Rhino numbers in the region based on the last year (TTM May–April) poaching trend (assuming 100% detection rate in KNP)

Number of mature individuals in largest subpopulation: 4,952 at end of 2015 in KNP with additional rhino in adjoining private reserves that form Greater KNP, using a 55.8% mature population structure (SADC RMG unpubl. data).

Number of subpopulations: > 300

Severely fragmented: Yes. Most subpopulations exist in small, fenced wildlife ranches. There has been some consolidation with a number of smaller owners exiting the industry and the number of larger subpopulations increasing.


Peter Chadwick

Habitats and Ecology

The species is found in grassland and bushveld savanna habitats favouring sweetveld areas. They have four basic habitat requirements (Skinner & Chimimba 2005): 1) areas of short grass, but including stands of medium-tall *Panicum maximum* found under trees (Shrader 2003) and *Themeda triandra* (Owen-Smith 1988); 2) the availability of drinking and wallowing water; 3) adequate bush cover; and 4) relatively flat terrain. They are essentially solitary with periods of sociality that can last from days to years (Shrader & Owen-Smith 2002). Group sizes usually range between two and five individuals. Male territories are non-overlapping and range from 0.75 km^2 to 13.9 km^2 in size, where the boundaries often form topographic features such as rivers, watersheds or roads (Skinner & Chimimba 2005). Population size is regulated through dispersal of individuals (mainly subadults of both sexes) from high to low density areas (Owen-Smith 1988), where subadults explore surrounding areas with a “buddy” (either an adult

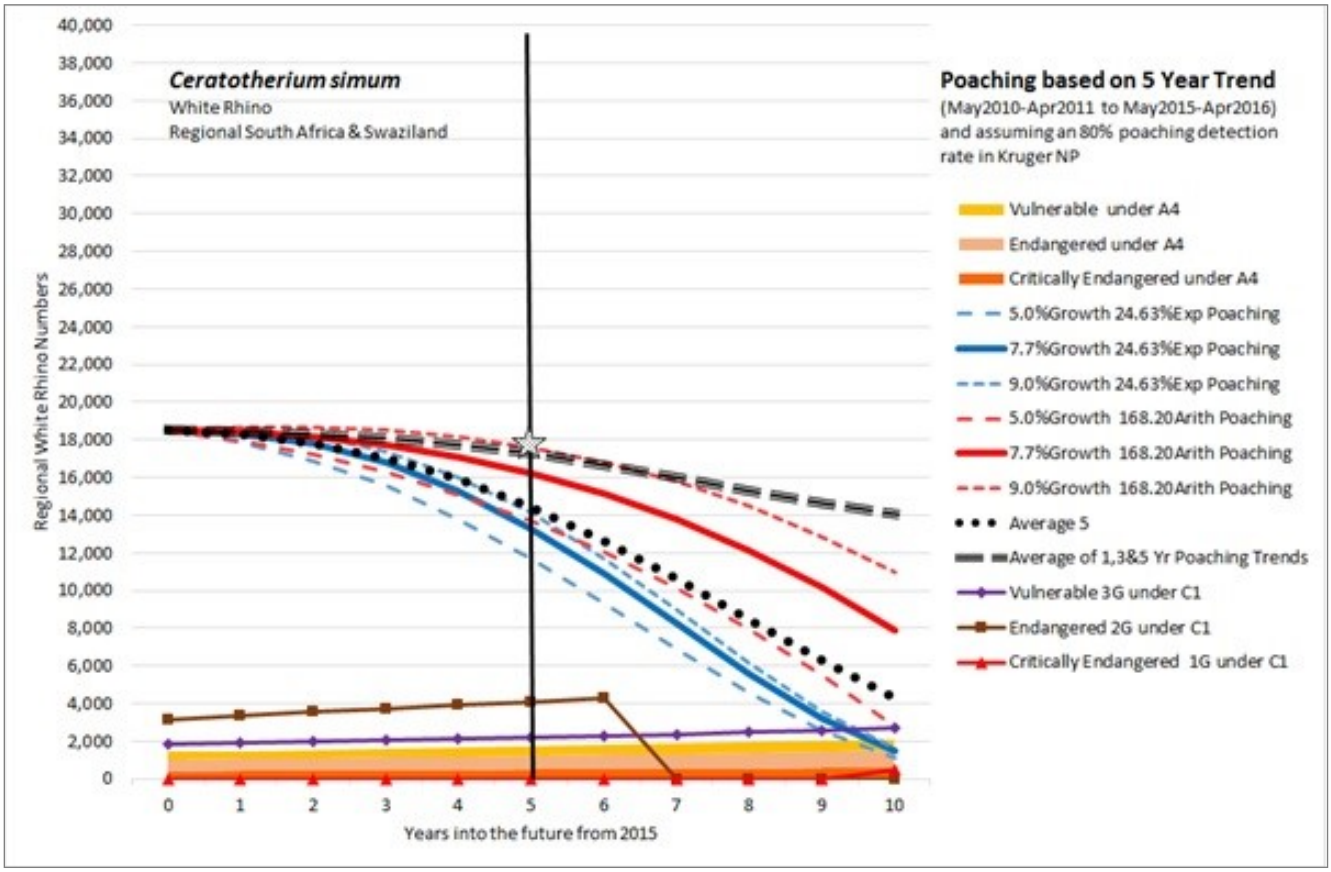

Figure 7. Modelling of total White Rhino numbers in the region based on the last five-year (TTM May–April) poaching trend (assuming 80% detection rate in KNP)

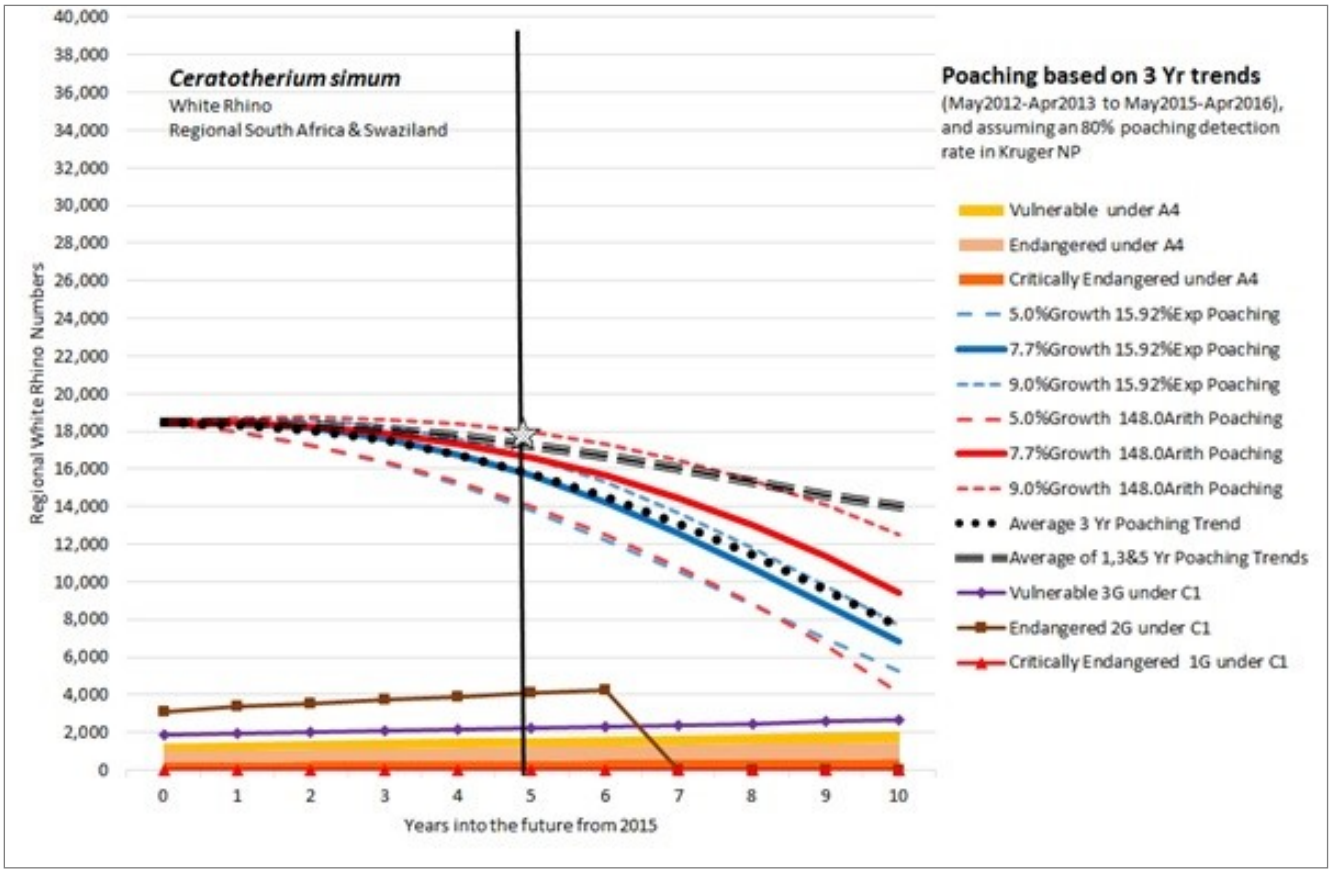

Figure 8. Modelling of total White Rhino numbers in the region based on the last three-year (TTM May–April) poaching trend (assuming 80% detection rate in KNP)

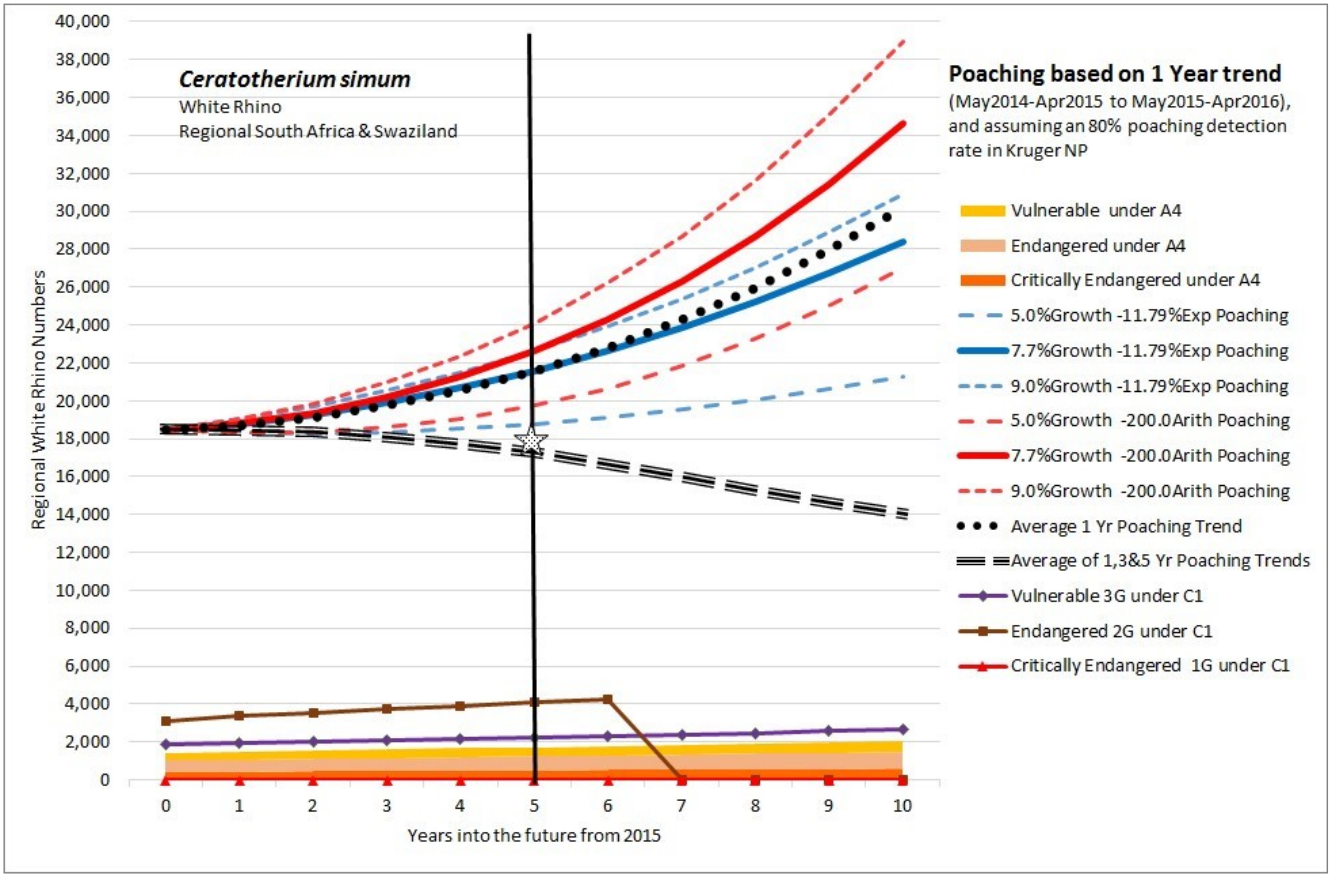

Figure 9. Modelling of total White Rhino numbers in the region based on the last year (TTM May-April) poaching trend (assuming 80% detection rate in KNP)

female lacking a calf or another subadult), which may be important in reducing the risks associated with dispersal (Shrader & Owen-Smith 2002).

White Rhinos are the world's largest purely graminivorous animal (Skinner & Chimimba 2005), capable of cropping grass to within 25–60 mm of the ground (Owen-Smith 1988). In KZN, seven grass species made up 73% of food intake (Shrader 2003). About 35 other grass species are eaten to a lesser extent (Skinner & Chimimba 2005), but species such as *Cymbopogon plurinodis*, *Bothriochloa insculpta* and *Aristida* spp. are avoided. They do not compensate for seasonal declines in food quality by switching to other species or increasing the number of species eaten and may instead draw on fat reserves during the dry season (Shrader et al. 2006).

Ecosystem and cultural services: White Rhinos act as ecosystem engineers by maintaining short grass patches (known as "lawns") and their removal affects fire patterns by increasing fuel load and fuel continuity (creating larger, less patchy fires) thereby decreasing landscape heterogeneity (Waldram et al. 2008; Cromsigt & te Beest 2014) and may lead to trophic cascades (Everatt et al. 2016). White Rhino help to create and maintain wallows that can be used by many other species and their dung middens create nutrient hot spots and germination sites for some species. White Rhino have also become a flagship symbol of the fight to conserve natural ecosystems and curb illegal wildlife trafficking, in part based on their previous conservation success story.

Use and Trade

Rhino horn was used historically as a traditional medicine in countries such as China and more recently used as luxury goods and status symbols, particularly in Vietnam (Graham-Rowe 2011; Milliken & Shaw 2012), as well as an investment. Previous conservation efforts have been so successful that it was possible to start limited trophy hunting in South Africa in 1968, and, at the 9th CITES Conference of the Parties, a partial downlisting of South Africa's White Rhino was approved for live sale to approved destinations and continued export of hunting trophies. A similar partial downlisting was also approved for Swaziland a decade later (2004). "Pseudo-hunting", where sport hunting was undertaken by individuals from non-traditional hunting countries as a source for illegal markets, declined from around 20% of hunts to probably less than 3% following the introduction of a number of control measures by South Africa in 2012 (Emslie et al. 2016).

While most subpopulations are considered wild, many subpopulations exist on extensive or semi-extensive ranchlands and private protected areas (23%) while a minority exist in semi-intensive or intensive systems (10%) (Tables 4 and 5). Extensive or semi-intensive systems are better than captive conditions to stimulate and sustain subpopulation growth (*sensu* Swaisgood et al. 2006), and can then be used to augment wild subpopulations (Table 5). Thus, both extensive and semi-intensive systems, due to high growth rates and concentrated law enforcement, may support wild subpopulations as sources for supplementation. Illegal poaching, however, is reducing the number of rhinos available to be translocated, thus limiting population expansion.

Due to the increasing threats and security costs and declining economic incentives, it was estimated that 63 owners (mainly those with small numbers that were difficult to protect) removed their White Rhino from 2012–

Table 4. Use and trade summary for the White Rhinoceros (*Ceratotherium simum simum*)

Category	Applicable?	Rationale	Proportion of total harvest	Trend
Subsistence use	No	Not hunted for bushmeat.	-	-
Commercial use	Yes	Limited numbers hunted legally for trophies and live animal sales; hunted illegally for the illicit trade in rhino horn.	All	Poaching increasing but pseudo-hunting has declined significantly since imposition of a suite of control measures by South Africa in early 2012. Only 64 White Rhinos were hunted in South Africa in 2015 (0.35% of the population).
Harvest from wild population	Yes	Tourism, live sales and limited trophy hunting for revenue generation. Limited dehorning for security.	Majority	Poaching reducing the number of animals available for legal revenue generation.
Harvest from ranched population	Yes	Tourism, live sales and limited trophy hunting for revenue generation. Dehorning for security in some smaller wild subpopulations.	*c*. 23%	Poaching reducing the number of animals available for legal revenue generation.
Harvest from captive population	Yes	Live sales for revenue generation. Dehorning for security.	*c*. 10% (six subpopulations)	Unknown

Table 5. Possible net effects of private ownership of White Rhino and subsequent management recommendations

Net effect	Positive
Data quality	Empirical
Rationale	Private landowners have greatly increased the area of occupancy and population size of wild White Rhino subpopulations within South Africa through reintroduction. Semi-intensive operations with partial supplementary feeding and concentrated law enforcement offer an insurance policy for founder rhinos to restock wild populations.
Management recommendation	Continue to encourage and provide incentives for private rhino ownership. Also seek ways for greater participation of communities in rhino conservation efforts and benefits.

14. At the same time, some private owners have increased their numbers, including moves to manage White Rhino under more intensive semi-wild conditions with some partial supplementary feeding, resulting in consolidation within the industry. Partial supplementary feeding in the semi-wild operations enables the White Rhinos to be stocked at higher than normal densities and security efforts to be concentrated, though requires significant costs. Provided there is no selective breeding or overdominance of breeding by some males, and poaching can be kept lower than the national average, such operations may provide an insurance policy as they could potentially provide founder rhino to restock wild areas in future if needed. Unlike very intensive zoo situations that have a generally poor reproductive performance, some semi-wild operations have demonstrated very good reproductive performance and population growth.

Threats

The main threats facing White Rhinos are the markets for horn from Asia and the scale and involvement of transnational organised crime in meeting this demand through trafficking horns. Since 2007, there has been an upsurge in black market prices and demand for horn which has caused an increase in poaching in some range states (Thomas 2010). Until recently, at a continental level, poaching of White Rhinos has not had a serious impact on overall numbers of White Rhinos, with poaching losses in parts of the range being surpassed by encouraging growth rates in others. From reported figures, the historical annual average poaching incidents during 2003 to 2005 represented just 0.2% of the total number of White Rhinos at the end of 2005 (Emslie et al. 2007), whereas by 2015 this had increased to 5.3% of Africa's White Rhino (Emslie et al 2016). White Rhino numbers in KNP increased rapidly over many decades but under the face of heavy poaching are most likely now declining (Ferreira et al. 2015; Emslie et al. 2016).

The total number of both species of rhino poached annually in South Africa has increased from 13 in 2007 to peak at 1,215 in 2014 before declining slightly to 1,175 in 2015. Numbers of White Rhino poached for the last 6 TTM years (May–April) are given in Table 2. The significant escalation of poaching since 2007, increased protection costs, declining live sale prices and reduced incentives are leading to increasing numbers of private owners in South Africa seeking to remove their rhino. Balfour et al. (2016) estimated 63 owners had disinvested of rhino over 3 years 2012–14. If the disinvestment trend continues this may threaten to reverse the expansion of range and has the potential to significantly reduce conservation budgets due to declining live sales and probable impacts on future live sale demand and prices. Simultaneously, some private rhino owners have increased their herd sizes, including moves to manage White Rhino under more intensive semi-wild conditions with some partial supplementary feeding, resulting in consolidation within the industry.

Table 6. Threats to the White Rhinoceros (*Ceratotherium simum simum*) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific literature	Data quality	Scale of study	Current trend
1	*5.1.1 Hunting & Collecting Terrestrial Animals*: poaching for horn.	Joint IUCN/TRAFFIC reports to CITES CoPs and AfRSG Chair reports in journal *Pachyderm*	Empirical	National	Increasing. Rhino poaching has been increasing since 2008, especially in KNP.
		Ferreira et al. 2016	Empirical	Local	
2	*12.1 Other Threat*: corruption in the enforcement of anti-poaching programmes and law enforcement agencies.	Bennett 2015	Indirect	Global	Ongoing given the involvement of organised crime paying very large sums for horn, and the money to be made from rhino crime.
3	*12.1 Other Threat*: increased costs and risks and declining / limited economic incentives for White Rhino range expansion.	AfRSG and SADC RMG data	Empirical	National	Increasing. Live White Rhino annual sale turnover from parastatals SANParks and Ezemvelo-KZN Wildlife declined from 2007–2012 by nearly US$3.8 million.
		Emslie & Knight 2014	Empirical	Regional	
		Balfour et al. 2016	Empirical	Regional	
4	*2.1.3 Annual & Perennial Non-timber Crops* and *2.3.3 Livestock Farming & Ranching*: historical habitat loss from agricultural expansion leading to isolated subpopulations. Current stresses *1.3 Indirect Ecosystem Effects* and *2.3.5 Inbreeding*: fragmentation and loss of genetic diversity through inbreeding and small founder size.	-	Anecdotal	-	Stable and being mitigated through establishment of new subpopulations and active translocation policies.

Throughout South Africa, declining management capacity and budgets in some formal conservation agencies have reduced the ability of conservationists to effectively mitigate anti-poaching campaigns (for example Adcock 2016). Additionally, the growing involvement of transnational crime networks have resulted in increased levels of corruption associated with wildlife crimes. Corruption in the networks involved in rhino conservation (for example, game farmers, veterinarians and park rangers), as well as security personnel (such as customs officials and police), enhances the resilience of criminal syndicates by supplying criminals with false documentation, laundering facilities for wildlife or products, and transport and holding facilities (Ayling 2013). Corruption is similarly entrenched in the illegal ivory trade (Bennett 2015). However, research into what anti-corruption interventions should be implemented is lacking (for example, Smith & Walpole 2005). Further collation of evidence for interventions to counteract corruption should be amassed.

Additionally, the increased militarisation of anti-poaching efforts in the face of increasing and more aggressive poaching threats is reported as having a negative effect on attitudes of neighbouring communities. The need to involve local communities in the benefits of rhino conservation initiatives is increasingly being recognised as a fundamental aspect of an integrated solution to the poaching crisis.

Current habitat trend: Stable. However, historical habitat loss from agricultural and human settlement expansion has led to isolated protected areas and thus the potential for inbreeding amongst small rhino subpopulations in the absence of occasional translocations to sustain genetic diversity. Exchange of at least one breeding animal / generation / subpopulation is mandated by the national conservation strategy for White Rhino (Knight et al. 2015). Changes in habitat are less of an issue for White Rhino than they can be for the browsing Black Rhino.

Conservation

White Rhinos were previously brought back from the brink of extinction through the establishment of protected areas on state and private land and reintroduction of rhinos back to their historic range (Emslie et al. 2009). By 1977, all African rhino species were listed on CITES Appendix I, and all international commercial trade in rhinos and their products was prohibited. However, following a continued increase in numbers, the South African population of Southern White Rhino was downlisted in 1994 to Appendix II, but only for trade in live animals to “approved and acceptable destinations” and for the (continued) export of hunting trophies. Numbers have almost trebled since then. In 2004, Swaziland’s Southern White Rhino were also downlisted to CITES Appendix II, but only for live export and for limited export of hunting trophies according to specified annual quotas. To help reduce illegal trade, and complement CITES international trade bans, domestic anti-trade measures and legislation were implemented in the 1990s by a number of the major consumer states and law enforcement efforts have been stepped up in many consumer countries. In addition to local, national, international and continental initiatives, there are a number of regional African rhino conservation initiatives: the SADC RMG, the recently formed East African Rhino Management Group and the Southern African Rhino and Elephant Security Group/Interpol Environmental Crime Working

Table 7. Conservation interventions for the White Rhinoceros (*Ceratotherium simum simum*) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context)

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	*2.1 Site/Area Management*: employ anti-poaching patrols and increased law enforcement.	Ferreira et al. 2015	Empirical	Local	Poaching increasing despite increased anti-poaching programmes.	SANParks, provincial agencies, private landowners, local and regional police, National Crime intelligence, National prosecuting authority
		Lee & Roberts 2016	Simulation	International	Dehorning unfeasible due to high costs.	
2	*5.4 Compliance & Enforcement*: increase prosecutions and custodial sentencing for poaching.	-	Anecdotal	-	-	SANParks, provincial agencies, private landowners, local and regional police, National Crime Intelligence, National Prosecuting Authority
3	*3.3.1 Species Reintroduction*: continue to increase population size and occupancy through reintroduction.	SADC RMG status report summaries (various)	Empirical	National	Positive rhino population growth rates (averaging over 4% regionally in the long-term) and increased breeding subpopulations.	Sales of rhino among private owners to establish new sites. Provincial and national conservation agencies each have rhino conservation plans and active management for their rhino areas.
4	*4.2 Training*: train law and customs officials to process rhino crime scenes and detect contraband; train specialist prosecutors, magistrates and police.	Internal and public reports from provincial and national conservation agencies, and NGOs like WWF and the EWT	Indirect	National	Increased prosecution of poachers.	Skills Development Unit, Endangered Wildlife Trust; Department of Environmental Affairs
5	*6.5 Linked Enterprises & Livelihood Alternatives*: employ educational campaigns, media and social marketing effort to reduce demand for rhino horn.	Olmedo 2015	Review	International	Unknown. Campaigns not consistently evaluated.	Chi campaign and others in Vietnam; WWF/TRAFFIC

Group. The IUCN SSC African Rhino Specialist Group is the continental coordinating body for rhino conservation in Africa.

Effective field protection of rhino subpopulations and their biological management has been critical to success. The majority of rhino remain in fenced sanctuaries, conservancies, rhino conservation areas and intensive protection zones where law enforcement efforts can be concentrated at effective levels. Monitoring has also provided information to guide biological management decision-making aimed at managing rhino subpopulations for rapid population growth. This has resulted in surplus animals being translocated to establish new subpopulations both within and outside the species' former range. However, increasing black market prices for rhino horn, and increased poaching of rhino and involvement of criminal syndicates in recent years pose a significant emerging threat to rhino populations.

Increasing efforts are being made to integrate local communities into conservation efforts and benefits. In South Africa, live sale of White Rhinos on auction (and limited sport hunting of surplus males) has also created incentives for private sector conservation and generated much needed funds which can help pay the high cost of successfully monitoring, protecting and managing rhino. In the region of 33% of South Africa's White Rhino are now managed by the private sector in South Africa (AfRSG data). However, as discussed above, incentives are declining while protection costs and risks have increased resulting in increased disinvestment by some South African private rhino owners. In KNP, there have been increased translocations from vulnerable areas and concentrated law enforcement efforts in an IPZ where most of the rhinos occur to mitigate increased losses from poaching. However, the value of establishing reintroduced subpopulations and the revenue generated through live sales has been eroded as there are fewer surplus animals for sale as a result of poaching (Emslie et al. 2016). For example, live White Rhino annual sale turnover from parastatals SANParks and Ezemvelo-KZN Wildlife declined from 2007–2012 by nearly US$3.8 million, primarily as

there were fewer surplus animals to sell due to poaching (Emslie & Knight 2014). Monitoring of trends in White Rhino sales and prices is becoming increasingly difficult as more and more sales now take place away from auctions and out of the public eye for security reasons (Emslie et al. 2016).

Anti-poaching enforcement alone is not a long-term solution as the scale of the economic drivers behind poaching is likely to overwhelm regulatory mechanisms (Challender & MacMillan 2014). Similarly, anti-poaching campaigns and operations alone will not reverse the poaching trend in KNP (Ferreira et al. 2015), as intensive anti-poaching programmes have at best slowed the escalation of poaching rates (Humphreys & Smith 2014). Unless fines are very high they may be viewed as a minor tax on turnover of criminal syndicates (and possibly an incentive to poach) and therefore handing down of custodial sentences is more likely to act as a deterrent. Additional measures such as dehorning can reduce the cost:benefit for poachers in smaller subpopulations but still requires good law enforcement as poachers will target whatever horn remains. In large areas, dehorning is unlikely to be a viable solution to complement anti-poaching patrols given the high financial and logistical costs (Lee & Roberts 2016) as well as aesthetic concerns in national parks and game reserves.

Some have proposed that legal international trade in rhino horn could form part of the solution (for example, Biggs et al. 2013; Ferreira et al. 2014), such as through raising capital for reinvestment into rhino conservation. However, others point out that the market is not well understood and/or we should focus on reducing demand through social marketing, education campaigns, lobbying and inter-governmental cooperation (for example, Collins et al. 2013; Nadal & Aguayo 2014; Challender & MacMillan 2014; Olmedo 2015; Crookes & Blignaut 2015). Similarly, there is concern that the capacity to regulate a legal trade is inadequate to prevent the laundering of illegal horn and subsequent increased poaching of wild animals (for example, Taylor et al. 2014; Bennett 2015).

In the longer term, integrated approaches, in addition to anti-poaching effort, are needed (Ferreira & Okita-Ouma 2012; Ferreira et al. 2014). These include:

1. Greater use of technology, especially in very large areas where it is not possible to have one field ranger / 7 to 10 km^2.
2. Disrupting international criminal networks through the use of social network analysis (Haas & Ferreira 2015). Previously, poachers were unsophisticated and informal whereas the current poaching crisis represents highly organised criminal syndicates that are resilient to disturbance (Ayling 2013), which necessitates targeting key players by law enforcers.
3. Congruent legal and extradition agreements between countries targeted by poachers and those harbouring poachers and horn dealers (Ferreira & Okita-Ouma 2012).
4. Demand reduction campaigns, including law enforcement action on those involved in illegal rhino horn consumption (Ferreira & Okita-Ouma 2012; Litchfield 2013; Emslie et al. 2016).
5. Provision of alternative economies in communities where poaching originates (Child 2012). Here it is proposed that devolving the ownership of rhinos to private, community and state landowners and providing bottom-up markets for legal hunting and trade might provide powerful economic incentives for rhino conservation (Child 2012). This also includes ongoing biological management efforts to maximise rhino subpopulation growth, coupled with land restitution processes and co-management that support community involvement and benefit-sharing from rhino conservation.

The above holistic approach is echoed by the recently released recommendations of the Committee of Inquiry established by the Department of Environmental Affairs (DEA 2016), which comprise:

1. Security, including the adoption and implementation of the National Integrated Strategy to Combat Wildlife Trafficking;
2. Community empowerment, including the development, adoption and implementation of a Community Empowerment Plan;
3. Biological management, including the adoption of an African Rhino Conservation Action Plan;
4. Responsive legislative provisions that are effectively implemented and enforced, including incentives to rhino owners to support continued investment in the conservation of rhino; and
5. Demand management, including information gathering to enhance our knowledge about demand for rhino horn and identifying the most effective interventions to manage demand.

Recommendations for land managers and practitioners:

- Adhere to the draft Continental African Rhino Plan and South African White Rhino Biodiversity and Management Plan (Knight et al. 2015) and be an active contributor to regular annual status reporting once it is introduced.
- Submit DNA samples collected by trained collectors using Rhino DNA Index System (RhODIS) kits to a RhODIS-compatible lab for inclusion in the global rhino DNA database. The RhODIS Rhino DNA Project allows the linking of blood and horn samples taken from suspects to known rhino carcasses for court cases, increasing chances of effective prosecution (Harper 2011).
- Invest in monitoring and protection.
- Collaborate with other rhino conservationists in both state, community and private sector and use intelligence-driven law enforcement.
- Implement the recommendations from the Committee of Inquiry (DEA 2016).

Research priorities:

- Effectiveness of strategies to curb poaching and testing of new law enforcement and surveillance methods and equipment.
- Improved intelligence analysis including that aimed at higher levels in criminal pyramids.
- Use the RhODIS data for forensic use in court and to help guide biological management (Harper 2011).
- Consumer demand profiles and what messaging may change behaviour.
- Finding ways to substantively get communities more involved in and sharing benefits of rhino conservation.
- Quantification of value and conservation benefits of sport hunting.
- Assessing the effectiveness and impacts of demand reduction and general education campaigns in end user markets.
- Quantify pros and cons of alternative policy options, including effects of legalising rhino horn trade.
- Setting up an annual reporting format as called for by South Africa's Biodiversity Management Plan (BMP; Knight et al. 2015).
- Biological management and security assessments of suitability of potential new areas for reintroducing rhinos.
- Holding a follow-up rhino biological management workshop.

Encouraged citizen actions:

- Provision of financial support for field conservation action.
- Landowners to continue to provide new land to allow for continued expansion of range and numbers (but will to some extent depend upon costs, risks and economic incentives).
- Become educated about wildlife trafficking and champion the reduction of illegal wildlife products.

Data Sources and Quality

Table 8. Information and interpretation qualifiers for the White Rhinoceros (*Cerototherium simum simum*) assessment

Data sources	Census (literature, unpublished), field study (literature, unpublished) – primarily SADC RMG and IUCN SSC AfRSG
Data quality (max)	Observed. Most populations are well monitored (mainly using individual identification-based methods with almost every individual animal known due to regular ear-notching programs).
Data quality (min)	Estimated. The largest subpopulation is estimated with confidence levels using intensive helicopter block counting. The second largest is monitored using line transects/point and distance sampling.
Uncertainty resolution	Confidence intervals
Risk tolerance	Evidentiary

References

Adcock K, editor. 2016. Status and management of black rhino in South Africa January 2012 to December 2014. SADC Rhino Management Group Report for the South African Department of Environmental Affairs.

Ayling J. 2013. What Sustains Wildlife Crime? Rhino Horn Trading and the Resilience of Criminal Networks. Journal of International Wildlife Law & Policy **16**:57–80.

Balfour D, Knight M, Jones P. 2016. Status of White Rhino on Private and Communal Land in South Africa: 2012 – 2014. Department of Environmental Affairs, Pretoria.

Bennett EL. 2015. Legal ivory trade in a corrupt world and its impact on African elephant populations. Conservation Biology **29**:54–60.

Biggs D, Courchamp F, Martin R, Possingham HP. 2013. Legal Trade of Africa's Rhino Horns. Science **339**:1038–1039.

Challender DWS, MacMillan DC. 2014. Poaching is more than an enforcement problem. Conservation Letters **7**:484–494.

Child B. 2012. The sustainable use approach could save South Africa's rhinos. South African Journal of Science **108**:21–25.

Collins A, Fraser G, Snowball J. 2013. Rhino poaching: supply and demand uncertain. Science **340**:1167–1167.

Cromsigt JPGM, te Beest M. 2014. Restoration of a megaherbivore: landscape-level impacts of white rhinoceros in Kruger National Park, South Africa. Journal of Ecology **102**:566–575.

Crookes DJ, Blignaut JN. 2015. Debunking the myth that a legal trade will solve the rhino horn crisis: A system dynamics model for market demand. Journal for Nature Conservation **28**:11–18.

DEA. 2016, May 8. Minister Edna Molewa on the Committee of Inquiry into the feasibility of a legal trade in rhino horn, or not. Committee of Inquiry recommendations, Department of Environmental Affairs, Pretoria. Available from https://www.environment.gov.za/mediarelease/molewa_onlegaltradeofrhinohornornot.

Emslie RH, Adcock K. 2016. A conservation assessment of *Diceros bicornis*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa

Emslie R, Brooks M. 1999. African Rhino. Status Survey and Conservation Action Plan. IUCN/SSC African Rhino Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. ix + 92 pp.

Emslie RH, Amin R, Kock R. 2009. Guidelines for the *in situ* re-introduction and translocation of African and Asian rhinoceros. IUCN, Gland, Switzerland. Available from http://www.iucn.org/dbtw-wpd/html/SSC-OP- 039/cover.html.

Emslie RH, Knight MH. 2014. Update on African Rhino Status and Poaching Trends from IUCN SSC African Rhino Specialist Group (AfRSG). IUCN briefing document for delegates attending the 65th CITES Standing Committee Meeting.

Emslie RH, Milledge S, Brooks M, Strien NJ, Dublin H. 2007. African and Asian Rhinoceroses – Status, Conservation and Trade. IUCN Species Survival Commission (SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat.

Emslie RH, Milliken T, Talukdar B, Ellis S, Adcock K, Knight MH. 2016. African and Asian Rhinoceroses - Status, Conservation and Trade. CITES CoP17 Doc 68 Annex 5. A report from the IUCN Species Survival Commission (IUCN SSC) African and Asian Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to Resolution Conf.9.14 (Rev. CoP15).

Everatt KT, Andresen L, Ripple WJ, Kerley GI. 2016. Rhino poaching may cause atypical trophic cascades. Frontiers in Ecology and the Environment **14**:65–67.

Ferreira SM, Greaver C, Knight GA, Knight MH, Smit IPJ, Pienaar D. 2015. Disruption of rhino demography by poachers may lead to population declines in Kruger National Park, South Africa. PLOS ONE **10**:e0127783.

Ferreira SM, Okita-Ouma B. 2012. A proposed framework for short-, medium-and long-term responses by range and consumer States to curb poaching for African rhino horn. Pachyderm **51**:52–59.

Ferreira SM, Pfab M, Knight M. 2014. Management strategies to curb rhino poaching: Alternative options using a cost-benefit approach. South African Journal of Science **110**:1–8.

Graham-Rowe D. 2011. Biodiversity: endangered and in demand. Nature **480**:S101–S103.

Groves CP, Fernando P, Robovskỳ J. 2010. The sixth rhino: a taxonomic re-assessment of the critically endangered northern white rhinoceros. PLoS One **5**:e9703.

Haas TC, Ferreira SM. 2015. Federated databases and actionable intelligence: using social network analysis to disrupt transnational wildlife trafficking criminal networks. Security Informatics **4**:1.

Harley EH, de Waal M, Murray S, O'Ryan C. 2016. Comparison of whole mitochondrial genome sequences of northern and southern white rhinoceroses (*Ceratotherium simum*): the conservation consequences of species definitions. Conservation Genetics:1–7.

Harper C. 2011. RhODIS–DNA profiling and a DNA database as a tool to protect the rhino. Pages 169–170in C. Dean, editor.Proceedings of the tenth meeting of the IUCN African Rhino Specialist Group. Mokala National Park, South Africa.

Humphreys J, Smith MLR. 2014. The "rhinofication" of South African security. International Affairs **90**:795–818.

Knight MH, Emslie RH, Smart R, Balfour D. 2015. Biodiversity Management Plan for The White Rhinoceros (*Ceratotherium simum*) in South Africa 2015-2020. Department of Environmental Affairs, Pretoria. South Africa.

Lee TE, Roberts DL. 2016. Devaluing rhino horns as a theoretical game. Ecological Modelling **337**:73–78.

Litchfield CA. 2013. Rhino poaching: apply conservation psychology. Science **340**:1168–1168.

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Details of the methods used to make this assessment can be found in *Mammal Red List 2016: Introduction and Methodology.*

Milliken T, Shaw J. 2012. The South Africa—Viet Nam rhino horn trade nexus: a deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates. TRAFFIC.

Nadal A, Aguayo F. 2014. Leonardo's sailors: A review of the economic analysis of wildlife trade. LCSV Working Paper Series No. 6. The Leverhulme Centre for the Study of Value, University of Manchester, UK.

Olmedo A. 2015. Evaluating behaviour change interventions: A case study in Vietnam. M.Sc. Thesis. Imperial College London, London, UK.

Owen-Smith NR. 1988. Megaherbivores: The Influence of very Large Body Size on Ecology. Cambridge University Press, Cambridge, UK.

Pienaar DJ. 1993. The landscape preference and horn attributes of the white rhinoceros *Ceratotherium simum simum* (Burchell, 1817) in the Kruger National Park. M.Sc. Thesis. University of Pretoria, Pretoria, South Africa.

Shrader AM. 2003. The use of food and space by white rhinos. Ph.D Thesis. University of the Witwatersrand, Johannesburg, South Africa.

Shrader AM, Owen-Smith N. 2002. The role of companionship in the dispersal of white rhinoceroses (*Ceratotherium simum*). Behavioral Ecology and Sociobiology **52**:255–261.

Shrader AM, Owen-Smith N, Ogutu JO. 2006. How a mega-grazer copes with the dry season: food and nutrient intake rates by white rhinoceros in the wild. Functional Ecology **20**:376–384.

Skinner JD, Chimimba CT. 2005. The Mammals of the Southern African Subregion. Cambridge University Press, Cambridge, England.

Smith RJ, Walpole MJ. 2005. Should conservationists pay more attention to corruption? Oryx **39**:251–256.

Swaisgood RR, Dickman DM, White AM. 2006. A captive population in crisis: Testing hypotheses for reproductive failure in captive-born southern white rhinoceros females. Biological Conservation **129**:468–476.

Taylor A, Brebner K, Coetzee R, Davies-Mostert H, Lindsey P, Shaw J, 't Sas-Rolfes M. 2014. The viability of legalising trade in rhino horn in South Africa. Department of Environmental Affairs (DEA) Pretoria, South Africa.

Thomas R. 2010. Surge in rhinoceros poaching in South Africa. TRAFFIC Bulletin **23**:3.

Waldram MS, Bond WJ, Stock WD. 2008. Ecological engineering by a mega-grazer: white rhino impacts on a South African savanna. Ecosystems **11**:101–112.

End Notes

1. Two White Rhino were poached in Swaziland in 2011 (May 2011–Apr 2012) and one in 2014 (May 2013–Apr2014).
2. A breakdown was not available for the rest of South Africa outside of KNP and KZN for the 16 months January 2015-April 2016, and for KNP for the first four months of 2016. The numbers of Black Rhinos poached for these 16 and 4 month periods for these areas was estimated on a pro rata basis using the average % rhinos poached that were Black Rhino for Jan 2010 up to Dec 2014 for Rest of South Africa and for Jan 2010 to Dec 2015 for KNP. While the proportion of Black Rhino to White Rhino poached in KNP was higher than usual in 2015 (5.2%), this has varied over the years without showing any obvious consistent trend up or down over time. Thus it was decided to use the longer term average 4.2%, rather than most recent proportion to, on a pro rata basis, estimate the numbers of Black Rhino poached in KNP for the first four months of 2016.