

# The future of private rhino ownership in South Africa

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**Abstract.** Sustained poaching over the past decade has led to significant loss of black (*Diceros bicornis*) and southern white (*Ceratotherium simum simum*) rhinoceroses across South Africa. Whereas much research has focussed on the heavily targeted state-owned populations, there is little understanding of the trends and challenges faced by rhino populations held in the private sector. Private rhino ownership has increased substantially across South Africa over the past three decades, with over 42% of the entire rhino population now in private ownership. Although total rhino numbers on private properties are still increasing, the number of properties owning rhinos is declining. This suggests a move away from traditional extensive properties to large, single-species breeding facilities, which are less valuable from a conservation perspective. The economic impact associated with increased poaching of rhinos over the past decade is the major challenge to private rhino ownership and may encourage disinvestment in rhinos. Some private rhino owners advocate for trade in rhino horn to generate the funds necessary for continued protection of their animals. However, other options to reduce disinvestment, such as local community-engagement projects, are likely to be more favourably received by the wider conservation industry.

**Additional keywords:** captive management, conservation management, human dimensions, threatened species, wildlife management.

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## Introduction

Across most of the world, conservation of megafauna is focussed within state-owned protected areas, where exploitation of species of conservation priority is either not permitted or is severely restricted. In a few countries, devolution of some of the financial responsibility for wildlife conservation to the private sector has helped reduce pressure on under-funded governments (Wilson *et al.* 2017). In South Africa, Zimbabwe, Botswana and Namibia, the private sector has become increasingly important for the conservation of black rhino (*Diceros bicornis* spp.) and southern white rhino (*Ceratotherium simum simum*) since the 1970s (Muir-Leresche and Nelson 2000). Private landowners are permitted to derive income from rhinos through tourism, trophy hunting, legal sale of horn within South Africa and breeding (Pienaar *et al.* 2017; Wilson *et al.* 2017), as long as they have the correct permits or certificates in place.

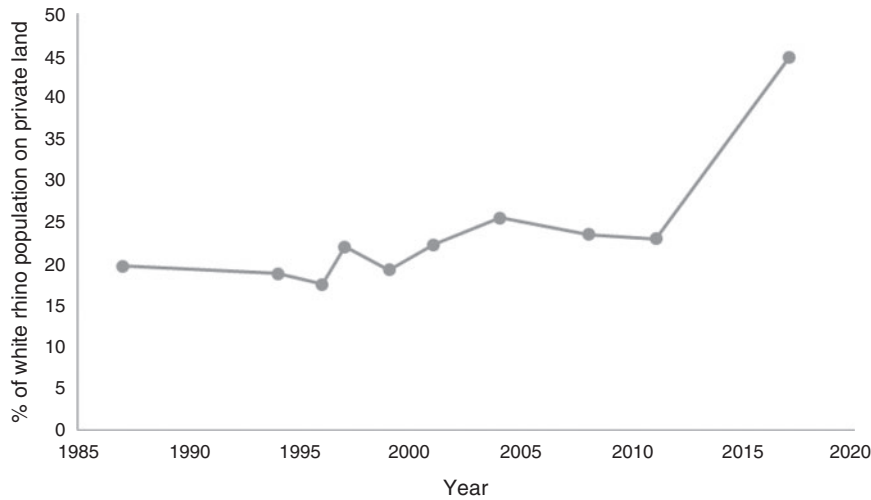
## Trends in private ownership of rhinos in South Africa

Freehold private land, dedicated to the management of wildlife, has proliferated in South Africa, Botswana, Namibia and Zimbabwe since the removal of subsidies for livestock rearing and the collapse of international agriculture markets (Carruthers 2008). In South Africa, 399 game farms had been identified by 1974 (Carruthers 2008), with the first commercial sales being held for white rhino in 1986 (Knight 2015) and black rhino in 1990 ('t Sas-Rolfes 1997). Rhino populations in South Africa have increased 10-fold since private ownership was permitted (DEA 2013), and, by the end of 2017, more than 40% of the

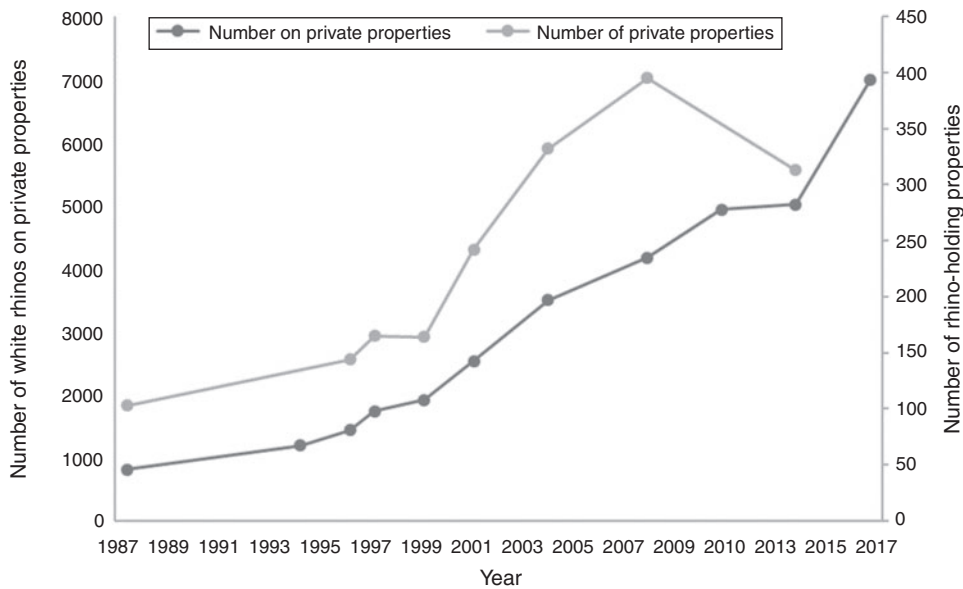
South African rhino population was privately owned (Fig. 1; Emslie *et al.* 2019).

At the same time, there has been disinvestment from rhino on some properties as a result of the impact of poaching. Balfour *et al.* (2015) estimated that 18.56% of owners disinvested in rhinos between 2012 and 2014, whereas Rubino and Pienaar (2018a) found that 78.8% of owners had considered disinvesting. Even though this disinvestment has reduced the number of private properties holding rhinos in South Africa, the privately owned white rhino population has continued to grow (Fig. 2). There is, therefore, concern that these rhinos are increasingly being held in intensive-breeding facilities.

Extensive private reserves contribute to biodiversity conservation through the maintenance of natural habitat and protection of native species, such as, for example, in the WWF's Black Rhino Range Expansion Project (BRREP; Cousins *et al.* 2008; Hayward *et al.* 2018). Increases in private ownership have played a key role in improving the IUCN classification of the white rhino to 'Near threatened' status (Emslie 2020), and 44 privately owned populations are recognised as 'Important' based on IUCN/SSC African Rhino Specialist Group classifications (Hall-Martin *et al.* 2008). If, as claimed by Ververs *et al.* (2017), these properties can maintain natural behaviour and genetic diversity among their stock, then they may act as reservoirs for reintroductions in the future. However, other researchers have raised concerns around genetic management, including over-reliance on individual breeding bulls and risks of domestication (Cousins *et al.* 2008; Hayward and Kerley 2009; Chapman and White 2020). Indeed,



**Fig. 1.** Percentage of South African rhino population held on private land, 1987–2017. Data from Emslie and Brooks (1999), Hall-Martin *et al.* (2008), du Toit (2013), Balfour *et al.* (2015) and Emslie *et al.* (2019).



**Fig. 2.** Number of rhino-holding properties and the privately owned white rhino population of South Africa, 1987–2017. Data from Buijs and Papenfus (1996), Buijs (1987, 1999), Emslie and Brooks (1999), Castley and Hall-Martin (2003), Hall-Martin *et al.* (2008), Balfour *et al.* (2015) and Emslie *et al.* (2019).

the ability of animals reared in intensive conditions to integrate into a natural environment is questionable, given that Rubino *et al.* (2018, p. 308) noted that a maximum stocking density of 1 km<sup>-2</sup> is required to indicate a ‘strong commitment to habitat conservation’. Small reserves are sometimes able to retain diverse communities through appropriate management (East 1981). However, in general, the concentration of the privately owned rhino population into a smaller number of larger properties is likely to reduce its conservation value and, potentially, also have an impact on the wider benefits of private reserves by reducing habitat availability for other wildlife.

The role of private ownership in continuing to increase the white rhino population of South Africa is critical, given the decrease in the state-owned population within the Kruger National Park, on the basis of Department of Environmental Affairs (DEA) data (Fig. 3). Although these data clearly show a population decline, the specific figures have been called into question, and independent analysis places the population in 2015 at no higher than 4585, which is less than 55% of the low estimate of 8365 released by the DEA (de Bruin 2015). If this is the case, then poaching deaths in the park in 2015 (826, DEA 2017) represent 27.53% of the total population and far outstrip natural white rhino population growth rates of 7.1%

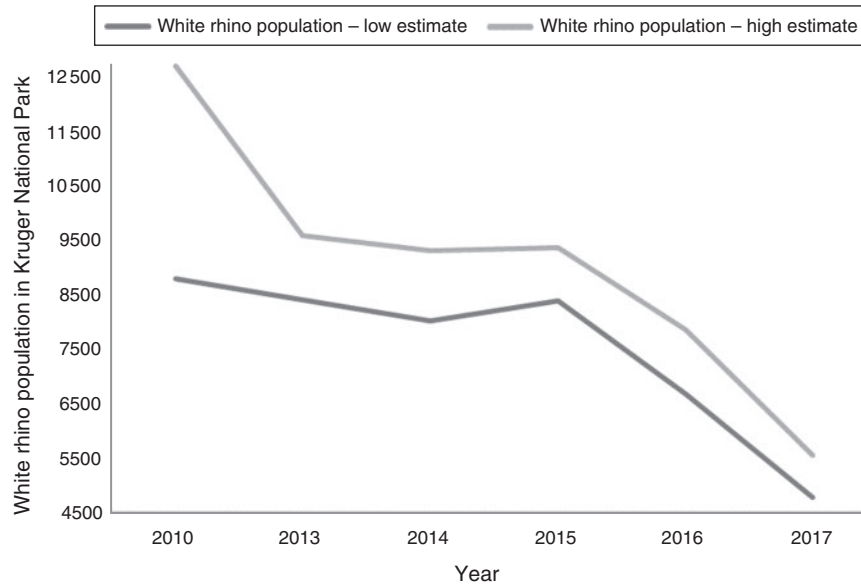


Fig. 3. Maximum and minimum white rhino populations in Kruger National Park (DEA 2015, 2017, 2018).

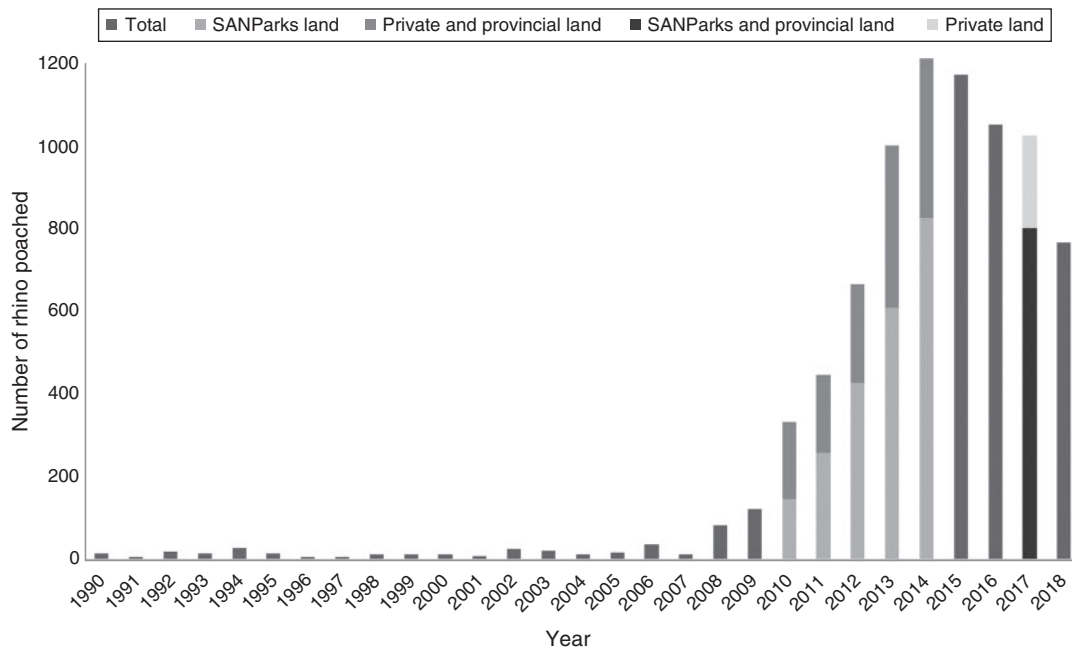


Fig. 4. Official rhino poaching statistics (Milliken and Shaw 2012; DEA 2014, 2016, 2019; Rhino Alive 2018). Poaching has been split by land-use types where such information was available.

(Emslie *et al.* 2019). The results of the most recent census of the Kruger rhino population have been withheld because of ‘some confusing results’ (Parliamentary Monitoring Group 2019), but South Africa’s rhino population may be under an even greater threat than has been acknowledged up to now.

**Challenges to private rhino ownership**

*Poaching*

The increasing contribution of the private sector to rhino populations has occurred despite continued poaching

pressure. Between 1990 and 2005, the average number of rhinos poached per year in South Africa was 14 (Milliken and Shaw 2012); this number increased to over 1000 between 2013 and 2017 (DEA 2014, 2017; Fig. 4). Although the official poaching statistics for 2018 (DEA 2019) indicated a substantial decrease in total poaching numbers, with the figure dropping below 1000 for the first time in 6 years, this figure has been questioned on the basis of changes in how the official figures are calculated (Saving the Survivors 2015; Phillips 2019).

Private rhino owners receive no government or NGO funding or support to protect their stock (Rubino and Pienaar 2018b) and, so, the costs of anti-poaching activities must be borne by the individual owners. The substantial expenditure required to protect stock from poaching has been identified by multiple authors as a potential reason for disinvestment (Balfour *et al.* 2015; Rubino and Pienaar 2018b; Wright *et al.* 2018).

### The future of private rhino ownership

After a rapid increase in the number of private properties in south Africa owning rhinos, disinvestment has now begun and there are indications that increasing numbers of rhinos are being held in intensive-breeding facilities. Owners are concerned about the economic implications of continuing to keep rhinos, especially the demands of increasing security expenditure, and many are also concerned about the known risks to personal safety that are a consequence of increasing poaching activity on their land (Balfour *et al.* 2015; Rubino and Pienaar 2018a; Wright *et al.* 2018).

#### *Horn trade*

The increasing economic burden of protecting stock has led some private rhino owners to suggest that trade in rhino horn is necessary to generate income to fund anti-poaching activities and reduce the risks of disinvestment (Jakins 2018; Chapman and White 2020). Rubino and Pienaar (2018a) found that 45.5% of owners identified horn as a good investment, with positive opinions towards horn trade being generally noted among private rhino owners (Wright *et al.* 2018; Rubino and Pienaar 2018a; Chapman and White 2020). One rhino owner (Hume 2013) and some researchers (Biggs *et al.* 2013) have suggested that lifting the international trade ban and further expanding the production of rhino horn would generate funds for further rhino conservation, reduce poaching and provide further incentives for the keeping of rhinos. However, this view has been dismissed by the chairman of the International Union for the Conservation of Nature and Natural Resources (IUCN) Species Survival Commission (SSC) African Rhino Specialist Group (AfRSG), Dr Mike Knight (Knight 2015, p. 12). It is also possible that lifting the international trade ban could lead to a higher level of demand, including new markets, resulting in higher poaching pressure. New technologies, such as unmanned aerial vehicles (UAVs), are already being deployed in response to high poaching pressure in some areas (Mulero-Pázmány *et al.* 2014). Increased demand could cause further escalations in the arms race between poachers and private rhino owners and exacerbate the already-high risks to personal safety that many private owners experience.

The government of South Africa has presented conflicting messages regarding its perceptions of the possibility of trade in rhino horn. At a cabinet meeting on 13 April 2016, it was agreed that South Africa would not apply to CITES to permit trade in rhino horn (Government Communication and Information System 2016), despite this proposal being included in the DEA 2016 budget (National Treasury 2016). The Government reintroduced domestic trade in rhino horn in 2017, but there are no data yet available on the levels of internal trade generated or the wider impacts of this decision. International trade in rhino horn is likely to be required to generate significant income for private

rhino owners because the market for rhino horn lies predominantly outside of South Africa. However, the intensification of rhino ownership may reduce the price that wildlife consumers are willing to pay for horn (Drury 2009).

The size of the potential market is also unclear. Some have suggested that legalising the trade in rhino horn could stimulate markets that have previously been dormant (Ferreira and Okita-Ouma 2012; Prins and Okita-Ouma 2013). There are also concerns that legal trade will further destigmatise consumption and inadvertently stimulate demand from those who would not choose to use an illegal product (Bulte and Damania 2005). With so many uncertainties regarding the potential for international trade in rhino horn, it should not currently be considered a 'silver bullet' to solve the rhino-poaching crisis and associated economic challenge.

#### *Local community engagement in rhino conservation*

Declines in the employment of local people and low levels of engagement of rangers with local communities can lead to poor relationships with local people (Butt 2012). Adcock and Emslie (1994) highlighted one private hunting operation that employed 14 full-time local staff and 15 others seasonally for 7 months of the year, equating to 24 full-time jobs. If each of those employees supported five other people, then almost 120 people were economically supported by that one private hunting operation. This model of local employment and training, generating a high community dependence on a private reserve, can help create peer pressure to reduce poaching risk from local people (Warchol and Johnson 2009). Moreover, if local people can be engaged as reserve allies, the information they provide regarding illegal activity in the area (Roe *et al.* 2015) can help reduce poaching risk. This local-engagement approach has been shown to be effective in reducing poaching for the Ruvuma Elephant Project in Tanzania (Lotter and Clark 2014). In South Africa, it could be encouraged through the use of community conservation schemes, including integrated community development projects (ICDPs), supported, both financially and developmentally, either by the South African Government or by NGOs.

Integrated community development projects (ICDPs) work successfully in other parts of the world. For example, an ICDP project in Northern Canada permits local communities some consumptive use of polar bears (Freeman and Wenzel 2006). One private rhino owner spoken to in the development of this article has developed an ICDP plan for their property in the Northern Cape (Ferreira 2015), whereby rhinos could be leased from government stocks, their offspring owned 90% by the landowner and 10% by three local community partners, and all profit would be split on the 90:10 principle mentioned. This landowner already has similar initiatives in place for several game species. With increasing tourism in the Karoo region, 20% of those tourists visiting game parks (Atkinson 2016), large numbers of privately owned rhinos in the Northern Cape (Balfour *et al.* 2015) and low levels of poaching in the province (Rhino Alive 2018), this appears to be an ideal place to develop such activities. The DEA (2013) has actively encouraged community management of white rhinos in collaboration with private rhino owners, by suggesting that private owners donate 4800 white rhinos to local communities (40 to each of 120 communities) and work with them to ensure a growth rate of 5%,

resulting in 29 000 by 2037. However, there is no evidence to suggest that this idea has ever been put into practice.

An expansion of ICDPs could potentially include integration with areas such as the Associated Private Nature Reserves (APNR) alongside the KNP. Kreuter *et al.* (2010) highlighted collaboration among private reserves in southern Africa as an example of community-based natural-resource management (CBNRM), regardless of whether their motives are primarily economic or based on concern for the natural environment. Although they focussed on two of the APNR reserves (Timbavati and Klaserie), the principles of collaborative land management, shared access to wildlife resources for viewing and hunting and engagement in local community initiatives (Kreuter *et al.* 2010) could equally be applied to collaborations among private rhino owners and between private owners and community-owned properties. Such collaborations between farmers to form large conservancies is common in Namibia (Barnes and de Jager 1996), but rare in South Africa.

## Conclusions

The number of white rhinos kept on private properties in South Africa represents a sizeable proportion of the total population in the country. It has contributed substantially to the increase in the total white rhino population and subsequent improvement in its IUCN risk rating, which has occurred despite substantial declines in the state-owned rhino population of the Kruger National Park. However, private rhino ownership faces significant economic challenges because of large increases in expenditure needed to reduce the risk of poaching. There is some indication that this is leading to disinvestment by owners of smaller populations, and an increase in larger, intensively managed populations, that are likely to be of a lower conservation value.

There have been calls from some private rhino owners for greater support from the Government, such as, for example, by permitting international trade in horn to generate income for use in anti-poaching expenditure, but more research is needed to understand the conservation consequences of such a change. Alternatives to legal trade in rhino horn, which may also mitigate some of the concerns around disinvestment and the risks of increasingly intensive rhino management, include local community engagement through ICDPs. These may provide a more effective and less controversial way forward, which would be more likely to garner wide support across Governments and NGOs.

## Conflicts of interest

The authors declare no conflicts of interest.

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## References

Adcock, K., and Emslie, R. (1994). The role of trophy hunting in white rhino conservation, with special reference to BOP Parks. In 'Proceedings of a Symposium on Rhinos as Game Ranch Animals', 9–10 September 1994, Onderstepoort, South Africa. (Wildlife Group, South African Veterinary Association.)

- Atkinson, D. (2016). Is South Africa's Great Karoo region becoming a tourist destination? *Journal of Arid Environments* **127**, 199–210. doi:10.1016/j.jaridenv.2015.12.006
- Balfour, D., Knight, M., and Jones, P. (2015). 'Status of White Rhino on Private and Communal Land in South Africa: 2012–2014.' (Department of Environmental Affairs: Pretoria, South Africa.)
- Barnes, J. I., and de Jager, J. L. V. (1996). Economic and financial incentives for wildlife use on private land in Namibia and the implications for policy. *South African Journal of Wildlife Research* **26**, 37–46.
- Biggs, D., Courchamp, F., Martin, R., and Possingham, H. P. (2013). Legal trade of Africa's rhino horns. *Science* **339**, 1038–1039. doi:10.1126/science.1229998
- Buijs, D. (1987). 'A Summary of the Introduction of White Rhino onto Private Land in the Republic of South Africa.' (Rhino and Elephant Foundation: Johannesburg, South Africa.)
- Buijs, D. (1999). 'Survey: White Rhinos on Private Land (October 1999).' (African Rhino Owners Association: Johannesburg, South Africa.)
- Buijs, D., and Papefus, T. (1996). 'White Rhinos on Private Land in SA.' (African Rhino Owners Association: Johannesburg, South Africa.)
- Bulte, E. H., and Damania, R. (2005). An economic assessment of wildlife farming and conservation. *Conservation Biology* **19**, 1222–1233.
- Butt, B. (2012). Commoditizing the safari and making space for conflict: place, identity and parks in East Africa. *Political Geography* **31**, 104–113. doi:10.1016/j.polgeo.2011.11.002
- Carruthers, J. (2008). 'Wilding the farm or farming the wild'? The evolution of scientific game ranching in South Africa from the 1960s to the present. *Transactions of the Royal Society of South Africa* **63**, 160–181. doi:10.1080/00359190809519220
- Castley, J. G., and Hall-Martin, A. J. (2003). The status of the southern white rhinoceros (*Ceratotherium simum simum*) on private land in South Africa in 2001. *Pachyderm* **34**, 33–44.
- Chapman, L. A., and White, P. C. L. (2020). Stakeholder perspectives on the value and challenges of private rhinoceros ownership in South Africa. *Human Dimensions of Wildlife* **25**, 187–197. doi:10.1080/10871209.2020.1697838
- Cousins, J. A., Sadler, J. P., and Evans, J. (2008). Exploring the role of private wildlife ranching as a conservation tool in South Africa: stakeholder perspectives. *Ecology and Society* **13**, 43. doi:10.5751/ES-02655-130243
- de Bruin, L. (2015). 'Kruger Rhino Numbers in Crisis, Says Expert.' Available at <https://oxpeckers.org/2015/06/kruger-rhino-numbers-in-crisis-says-expert/> [verified 12 May 2019].
- Department of Environmental Affairs (DEA) (2013). Rhino issue management report 2013. Department of Environmental Affairs, Pretoria, South Africa.
- Department of Environmental Affairs (DEA) (2014). 'South African Government is Aware that Ongoing Scourge of Rhino Poaching is Linked to Worldwide Illicit Wildlife Trade.' Available at [www.environment.gov.za/mediarelease/rhinopoaching\\_wildlifetrade](http://www.environment.gov.za/mediarelease/rhinopoaching_wildlifetrade) [verified 1 May 2016].
- Department of Environmental Affairs (DEA) (2015). 'Minister Edna Molewa Highlights Progress in the Fight against Rhino Poaching 30 August 2015.' Available at [https://www.environment.gov.za/mediarelease/molewa\\_highlightsprogress\\_onrhinopoaching](https://www.environment.gov.za/mediarelease/molewa_highlightsprogress_onrhinopoaching) [verified 12 May 2019].
- Department of Environmental Affairs (DEA) (2016). 'Minister Edna Molewa Highlights Progress in the Fight against Rhino Poaching.' Available at [www.environment.gov.za/mediarelease/molewa\\_highlightsprogress\\_againstrhinopoaching](http://www.environment.gov.za/mediarelease/molewa_highlightsprogress_againstrhinopoaching) [verified 20 February 2019].
- Department of Environmental Affairs (DEA) (2017). 'Minister Molewa Highlights Progress on Integrated Strategic Management of Rhinoceros.' Available at [www.gov.za/mediarelease/DEA\\_progressonintegrated\\_strategicmanagement\\_ofrhinoceros](http://www.gov.za/mediarelease/DEA_progressonintegrated_strategicmanagement_ofrhinoceros) [verified 3 March 2017].
- Department of Environmental Affairs (DEA) (2018). 'Department of Environmental Affairs Highlights Progress on the Implementation of the Integrated Strategic Management of Rhinoceros.' Available at

- <https://www.environment.gov.za/mediarelease/progressonimplementationofISMR> [verified 26 May 2019].
- Department of Environmental Affairs (DEA) (2019). 'Minister Nomvula Mokonyane Highlights Progress on the Implementation of the Integrated Strategic Management of Rhinoceros and other Associated Endangered Species in SA 13 February 2019.' Available at [https://www.environment.gov.za/mediarelease/mokonyane\\_2018integratedstrategic\\_managementofrhinoceros\\_2019feb](https://www.environment.gov.za/mediarelease/mokonyane_2018integratedstrategic_managementofrhinoceros_2019feb) [verified 11 May 2019].
- Drury, R. (2009). Reducing urban demand for wild animals in Vietnam: examining the potential of wildlife farming as a conservation tool. *Conservation Letters* **2**, 263–270. doi:10.1111/j.1755-263X.2009.00078.x
- du Toit, J. G. (2013). Problems in rhino conservation in South Africa. In 'The Story of the White Rhinoceros'. (Ed. J. G. du Toit.) pp. 18–25. (Kejafa Knowledge Works: Krugersdorp, South Africa.)
- East, R. (1981). Species-area curves and populations of large mammals in African savannah reserves. *Biological Conservation* **21**, 111–126. doi:10.1016/0006-3207(81)90074-4
- Emslie, R. (2020). *Ceratotherium simum*. In 'The IUCN Red List of Threatened Species 2012: e.T4185A45813880'. Available at <https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T4185A45813880.en> [verified 4 April 2020].
- Emslie, R. H., and Brooks, M. (1999). 'African Rhino: Status Survey and Conservation Action Plan.' (IUCN: Gland, Switzerland.)
- Emslie, R. H., Milliken, T., Talukdar, B., Burgess, G., Adcock, K., Balfour, D., and Knight, M. H. (2019). African and Asian rhinoceroses: status, conservation and trade. 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 Conference 9.14 (Rev. CoP17) (No. CoP18 Doc. 83.1 Annex 2). CITES Secretariat, Geneva, Switzerland.
- Ferreira, P. C. (2015). 'Karoo Gariep Nature Reserve Rhino Conservation Business Plan.' (Karoo Gariep Nature Reserve: Hanover, South Africa.)
- Ferreira, S. M., and 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.
- Freeman, M. M. R., and Wenzel, G. W. (2006). The nature and significance of polar bear conservation hunting in the Canadian Arctic. *Arctic* **59**, 21–30.
- Government Communication and Information System (2016). 'Statement on the Cabinet Meeting of 13 April 2016.' Available at [www.gcis.gov.za/newsroom/media-releases/statement-cabinet-meeting-13-april-2016](http://www.gcis.gov.za/newsroom/media-releases/statement-cabinet-meeting-13-april-2016) [verified 20 February 2019].
- Hall-Martin, A. J., du Toit, J. G., Hitchens, P. M., and Knight, M. H. (2008). 'An Exert of the 2008 Survey of White Rhinoceros, *Ceratotherium simum simum*, on Private Land in South Africa.' (WWF-African Rhino Programme: Cape Town, South Africa.)
- Hayward, M. W., and Kerley, G. I. H. (2009). Fencing for conservation: restriction of evolutionary potential or a riposte to threatening processes? *Biological Conservation* **142**, 1–13. doi:10.1016/j.biocon.2008.09.022
- Hayward, M. W., Ripple, W. J., Kerley, G. I. H., Landman, M., Plotz, R. D., and Garnett, S. T. (2018). Neocolonial conservation: is moving rhinos to Australia conservation or intellectual property loss? *Conservation Letters* **11**, e12354. doi:10.1111/conl.12354
- Hume, J. (2013). Saving rhino from extinction. *African Indaba* **11**, 14–17.
- Jakins, C. (2018). A discussion of rhino horn domestic trade legalisation in South Africa. *Acta Criminologica: Southern African Journal of Criminology* **31**, 169–185.
- Knight, M. (2015). Calling all rhino owners: how can you, the private rhino owner, help to solve the rhino crisis? *Wildlife Ranching* **4**(Rhino Suppl.), 9–13.
- Kreuter, U., Peel, M., and Warner, E. (2010). Wildlife conservation and community-based natural resource management in southern Africa's private nature reserves. *Society & Natural Resources* **23**, 507–524. doi:10.1080/08941920903204299
- Lotter, W., and Clark, K. (2014). Community involvement and joint operations aid effective anti-poaching. *Parks* **20**, 19–28. doi:10.2305/IUCN.CH.2014.PARKS-20-1.WL.en
- Milliken, T., and 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: Johannesburg, South Africa.)
- Muir-Leresche, K., and Nelson, R. H. (2000). 'Private Property Rights to Wildlife: the Southern African Experiment.' ICER Working Paper 02-2000. (International Centre for Economic Research: Torino, Italy.)
- Mulero-Pázmány, M., Stolper, R., van Essen, L. D., Negro, J. J., and Sassen, T. (2014). Remotely piloted aircraft systems as a rhinoceros anti-poaching tool in Africa. *PLoS One* **9**, e83873. doi:10.1371/journal.pone.0083873
- National Treasury (2016). '2016 Budget. Estimates of National Expenditure.' Available at [www.treasury.gov.za/documents/national%20budget/2016/enebooklets/Vote%2027%20Environmental%20Affairs.pdf](http://www.treasury.gov.za/documents/national%20budget/2016/enebooklets/Vote%2027%20Environmental%20Affairs.pdf) [verified 20 February 2019].
- Parliamentary Monitoring Group (2019). 'SANParks & SANBI Annual Performance Plan & Quarter 4 Performance with Minister Environment, Forestry and Fisheries.' Available at [pmg.org.za/committee-meeting/28760/?utm\\_campaign=minute-alert&utm\\_source=transactional&utm\\_medium=email&fbclid=IwAR1qsGgBy7s7x5de5uBdKjVjX76avJ3uDgtg363DLpUuiFBioFh6thM8](http://pmg.org.za/committee-meeting/28760/?utm_campaign=minute-alert&utm_source=transactional&utm_medium=email&fbclid=IwAR1qsGgBy7s7x5de5uBdKjVjX76avJ3uDgtg363DLpUuiFBioFh6thM8) [verified 12 September 2019].
- Phillips, L. (2019). Latest rhino poaching statistics called into question. Available at [www.farmersweekly.co.za/argi-news/south-africa/latest-rhino-poaching-statistics-called-into-question/](http://www.farmersweekly.co.za/argi-news/south-africa/latest-rhino-poaching-statistics-called-into-question/) [verified 6 March 2019].
- Pienaar, E. F., Rubino, E. C., Saayman, M., and van der Merwe, P. (2017). Attaining sustainable use on private game ranching lands in South Africa. *Land Use Policy* **65**, 176–185. doi:10.1016/j.landusepol.2017.04.005
- Prins, H. H. T., and Okita-Ouma, B. (2013). Rhino poaching: unique challenges. *Science* **340**, 1167–1168. doi:10.1126/science.340.6137.1167-b
- Rhino Alive (2018). 'South Africa: National Rhino Poaching Statistics: Detailed Analysis of the 2017 Statistics.' Available at [www.facebook.com/RhinoAlive/photos/a.455648507965862/745294002334643/?type=3&theater](https://www.facebook.com/RhinoAlive/photos/a.455648507965862/745294002334643/?type=3&theater) [verified 23 February 2019].
- Roe, D., Cooney, R., Dublin, H., Challender, D., Biggs, D., Skinner, D., Abensperg-Traun, M., Ahlers, N., Melisch, R., and Murphree, M. (2015). 'Beyond Enforcement: Engaging Communities in Tackling Wildlife Crime.' (IIED: London, UK.)
- Rubino, E. C., and Pienaar, E. F. (2018a). Rhinoceros ownership and attitudes towards legalization of global horn trade within South Africa's private wildlife sector. *Oryx*. doi:10.1017/s0030605318000030
- Rubino, E. C., and Pienaar, E. F. (2018b). Understanding South African private landowners decisions to manage rhinoceroses. *Human Dimensions of Wildlife* **23**, 160–175. doi:10.1080/10871209.2018.1402971
- Rubino, E. C., Pienaar, E. F., and Soto, J. R. (2018). Structuring legal trade in rhino horn to incentivize the participation of South African private landowners. *Ecological Economics* **154**, 306–316. doi:10.1016/j.ecolecon.2018.08.012
- Saving the Survivors (2015). 'Things you Never Knew about Poaching Statistics.' Available at <https://www.facebook.com/savingthesurvivors/photos/a.727427787298531/918972144810760/?type=3&theater> [verified 11 May 2019].
- 't Sas-Rolfes, M. (1997). 'Does CITES Work? Four Case Studies.' IEA Environment Briefing No. 4. (Africa Resources Trust: London, UK.)
- Ververs, C., van Zijll Langhout, M., Hostens, M., Otto, M., Govaere, J., Durrant, B., and Van Soom, A. (2017). Reproductive performance parameters in a large population of game-ranching white rhinoceroses (*Ceratotherium simum simum*). *PLoS One* **12**, e0187751. doi:10.1371/journal.pone.0187751

- Warchol, G., and Johnson, B. (2009). Wildlife crime in the game reserves of South Africa: a research note. *International Journal of Comparative and Applied Criminal Justice* **33**, 143–154. doi:[10.1080/01924036.2009.9678800](https://doi.org/10.1080/01924036.2009.9678800)
- Wilson, G. R., Hayward, M. W., and Wilson, C. (2017). Market-based incentives and private ownership of wildlife to remedy shortfalls in government funding for conservation. *Conservation Letters* **10**, 485–492. doi:[10.1111/conl.12313](https://doi.org/10.1111/conl.12313)
- Wright, O. T., Cundill, G., and Bigg, D. (2018). Stakeholder perceptions of legal trade in rhinoceros horn and implications for private reserve management in the Eastern Cape, South Africa. *Oryx* **52**, 175–185. doi:[10.1017/S0030605316000764](https://doi.org/10.1017/S0030605316000764)

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