

## CORRESPONDENCE



# Risky conclusions regarding shrinking rhino horns

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## Abstract

1. Image-based analyses from an online repository on rhino horns asserted that declines in size over time could be the consequence of poaching and hunting.
2. We provide reflections on whether the sample was representative enough to make generalizations, the study adequately accounted for the main sources of horn-size variation and the statistical methods were adequate to be confident in the results.
3. The sample had a limited representation, most coming from zoo animals. We highlight several sources of variance in horn size that such a sample could not evaluate robustly using linear regressions, both for establishing a proxy for horn size corrected for size of a rhino and assessing trends over time.
4. Nevertheless, horn poaching continues to be the key threat to rhinos. Addressing the underlying drivers of poaching and trafficking are key priorities for responsible public debate, policy making and interventions.

## KEYWORDS

poaching, rhino horn, trophy hunting

Rhinoceroses (rhinos) and images of rhinos capture the imagination: They inspire people to want to save them as a species and as symbols of broader biodiversity. A recent image-based analysis noted a change in the emphasis of rhinos portrayed as hunting trophies to a focus on them in a conservation context (Wilson et al., 2022). The analyses evaluated the change in rhino representations by means of 3158 images, used a sample of profile photographs, and extracted morphological data to evaluate changes in horn length over time. Based on a sample of 80, the study reported ostensible evidence for the decline in horn length over time and linked this to selective

pressure from illegal and legal hunting, that is, poaching and trophy hunting.

Historical data sets and images, such as those held by the Rhino Resource Center (Rookmaaker, 2003), provide opportunities to help identify patterns over time. However, a robust evaluation should use rigorous analyses and evaluate hypotheses that consider multiple factors that contribute to the variance in rhino horn sizes. Using the sample of 80 observations in four species, where only 12 observations came from wild rhinos, ignores image bias introduced by hunter and photographer satisfaction (Child & Darimont, 2015) and

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disregards multiple influences in the wild on horn size. These sampling features impose significant limitations on concluding anything about trends in horn size, including that they may have declined over time.

A rhino's horns grow continuously from a growth layer at the base of the horn (Boy et al., 2015). Although African black and white rhinos have similar intrinsic horn growth rates, irrespective of sex, the rate varies with age (Pienaar et al., 1991). Intrinsic maximum horn growth is up to 150 mm per year for a maturing rhino, but this slows as the rhino ages. Over time, intrinsic anterior horn growth averages 50 mm per year for both African species.

While the horn continues to grow from the base, it is also continuously worn away. The shape and length of the observed horns are in part determined by the way that rhinos use and rub their horns where they live. Rhinos use their horns for various purposes, including accessing branches for browsing and rubbing their horns on objects such as trees, rocks and anthills (Owen-Smith, 1973). Rubbing activities result in visible wear on all horn surfaces and are generally performed more by males than females (Pienaar et al., 1991).

Environmental conditions can also influence the incidence of horn rubbing; for example, rhinos in captivity are observed to rub their horns intensely and can substantially alter their shape and size and/or have abnormal abrasions of their horns (Groves, 1971). This results from rubbing above the usual level shown by wild rhinos and is associated with behaviour displacement activities despite enrichment programmes in captive facilities (Hutchins & Kreger, 2006). Given that 68 of the 80 images used in the analysis were from captive rhinos, it is likely that ex situ influences on rhino behaviour significantly compromised the generalizable conclusions of the study.

The behaviour of free-ranging rhinos also influences their horn shape and size, and this may differ from place to place. The black rhino horns in the Kaokoveld region in Namibia are straighter than those of KwaZulu-Natal, most likely due to different wear patterns (Skinner & Smithers, 1990) but potentially also due to local variation and differences between sub-species. Furthermore, white rhino cows have longer but thinner horns than white rhino bulls in the Hluhluwe-iMfolozi Park, but not so in Kruger National Park (Pienaar et al., 1991). This difference is believed to be associated with the territorial behaviour of bulls (Rachlow et al., 1998) and interactions between mature males; that is, it affects how they rub their horns using available objects in the landscape. Furthermore, within species, the lengths of the rhino horn differ between regions. Black rhinos in eastern Africa, the source of the world record for a black rhino horn (Dolman & Burlace, 1935), have substantially longer horns, on average, than black rhinos in southern Africa (Western & Sindiyo, 1972). This may link to genetic and or subspecies differences but is likely also due to behavioural opportunities exploited by rhinos in landscapes that offer different combinations of objects for rubbing horns.

These examples of sources of variance in horn morphology limit the use of robust statistical analyses, particularly using linear models, when few or no samples are available from some of the

(sub)-species across some time periods of interest.<sup>1</sup> Additionally, response variables (i.e. residuals from a regression of horn length to body length measured from the photos) are most likely heteroscedastic. The small sample size, particularly of wild rhinos, limits assumptions that these are representative of the populations of each species at a particular time. Ideally, the study could benefit from examining each species independently as they have experienced different histories and pressures over time (Ferreira et al., 2022). In addition, the parameters differ so much between in situ and ex situ that comparing and/or pooling data limits robust statistical analysis.

Even so, the study used a proxy index for horn length scaled for different sizes of rhinos, that is, residuals from a regression of horn length to body length measured from the photos. The coefficient of determination ( $R^2$ ) of the relationship the authors found between the length of the horn and the length of the body was 0.182. Therefore, body length explained a very low proportion of the variance in horn length. Residuals would then have many unaccounted additional sources of variance.

Using a linear regression, when there is such a large scatter in the residuals, could benefit from illustrating confidence limits around these lines and/or providing the statistical significance of the slope to help interpretation. This is particularly challenging given the small number of observations per species (three species have less than 20 observations), the wide dispersal of observations in the scatterplots, and the high number of effects that a model would need to account for. Differences in the coefficient of variance (CV) of residuals between periods serve as illustration.<sup>2</sup> For white rhinos in the 2000s it was 82%. The CVs for black rhino residuals in the 1900s and 2000s were 78% and 69% respectively. Importantly, the measured difference in the estimated mean residuals of black rhino in the 1900s and 2000s was not significant ( $p=0.28$ )<sup>3</sup> with a large overlap in confidence levels around the means.

Our brief reflection highlights multiple sources of variance in the lengths of African rhino horns. The small sample size, with its focus on captive animals, used by the Wilson et al. (2022) study constrains the ability to evaluate the multitude of drivers that include trends over time and to generalize conclusions to rhinos in the wild. This is supported by the statistical results reported by the study. Notwithstanding that most samples are from captive animals, the fixed effect (i.e. time) accounted for less than 3% of the variance, while random effects, (i.e. mostly species differences) accounted for 68% of the variance.

<sup>1</sup>In several cases there were no or only a few samples for some species in many of the time periods analysed. Sumatran rhino: there is only a single historical datapoint for wild animals in the 1900s. Javan rhino: regression had five wild samples with no historical wild samples before 1980. Greater one-horned rhino: two samples of wild rhinos. White rhino: no wild samples for the first half of the 20th century, before the very limited trophy hunting period started and an overall total sample of two wild rhinos. Black rhino: a sample two wild black rhinos, one per time-period.

<sup>2</sup>We estimated approximate residual values from measuring and scaling from a zoomed fig. 6 in the study using a ruler. This allowed the estimation of coefficients of variation for these residuals.

<sup>3</sup>Using a t-test for differences between means assuming unequal variances.  $p>0.28$  assuming unequal variances.

The strong influences of the species differences reported in the study are not surprising. What is surprising is the primary conclusion of the study of decreasing sizes over time and attributing this to hunting, whether legal for trophies or illegal, that is, poaching. To determine whether poaching has had an impact on horn length, it assumes that the major driver of horn length is genetics rather than environment or behaviour and that hunters (legal or illegal) would have selected rhinos with longest horns with sufficient frequency to remove these genes from the gene pool before they reproduced.

In practice, selecting rhinos with long horns sufficiently frequently does not occur in rhino populations. The decline in rhino numbers worldwide in the 20th century is primarily due to poaching, not legal trophy hunting (Chanyandura et al., 2021), to supply the demand for illegal rhino horn in Asia (Nožina, 2019). The poaching of rhino horn generally involves little selective killing and targets whatever horn is available with least risk (Haas & Ferreira, 2018). This practice is demonstrably different from selective hunting and poaching practices that resulted in the decrease in tusk size of elephant (Chiyo et al., 2015).

We find it risky to conclude that a possible but not demonstrated reduction in rhino horn length over time has been caused by selective hunting and, further, hunting that makes no distinction between (illegal) poaching and legal trophy hunting. This conclusion is not empirically supported by the evidence presented in the paper in any meaningful way.

Additionally, at the end of 2021, the world had somewhere between 34 and 47 Sumatran, 76 Javan, ~4014 greater one-horned, ~6195 black and ~15,942 white rhinos in the wild (Ferreira et al., 2022). During the preceding decade, legal trophy hunting ('t Sas-Rolfes et al., 2022) removed 0.34% (range: 0.06%–0.56%) of Africa's rhinos annually, that is, on average 11.5 times less than 3.9% (range: 2.3%–5.3%) of the continental population poached each year (Ferreira et al., 2022). In this context, the study, which implies that legal trophy hunting was responsible for the shrinkage of horn lengths, risks distracting attention from the establishment of appropriate policies and interventions to address the real problem: the drivers of poaching criminality (BBC, 2022a). In addition, most of the limited numbers of rhinos hunted for sport will be older animals that have had the opportunity to pass on their genes to the next generation before being hunted.

Evidence suggests that when rhinos must, they can cope without their horns (Penny et al., 2021). Sadly, removing much of the horn is an important complementary tool that is being implemented to help protect rhinos from poaching (Lindsey & Taylor, 2011). In fact, dehorning appears to effectively reduce the incentive for a poacher to kill a rhino in some instances (Milner-Gulland et al., 1994).

An additional concern raised by the publication of this article is the effect of irresponsible messaging. For example, media reporting 'Rhino poaching: Are rhinos evolving to grow smaller horns?' (BBC, 2022b), may result in poachers concluding that 'I had better get my hands on some horns before they get even smaller'. It predicts a media-framing effect (Glenn et al., 2019) that can increase poaching pressure on already at-risk populations.

The most impactful threat to Africa's rhinos continues to be their illegal killing to supply those who traffic their horns (Chanyandura et al., 2021). Addressing criminality and transnational organized crime, and the underlying drivers of these activities (Hübschle, 2016), is the priority requirement and should be the focus of responsible public debate, policy making and interventions.

## AUTHOR CONTRIBUTIONS

Keitumetse Mosweu wrote, formatted, edited and submitted the manuscript. Salomon Marthinus Ferreira wrote and edited the manuscript. Michael Harrison Knight, Joanne Aileen Shaw, and Lucy Vigne edited the manuscript. All other authors contributed to the conceptual development of the manuscript.

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## CONFLICT OF INTEREST STATEMENT

No conflict of interest to declare.

## DATA AVAILABILITY STATEMENT

This manuscript does not include any data.

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**How to cite this article:** Ferreira, S. M., 't Sas-Rolfes, M., Balfour, D., Barichiev, C., Chege, G., Dean, C., Doak, N., Dublin, H. T., du Toit, R., Ellis, S., Emslie, R. H., Flamand, J., Gadd, M., Gaymer, J., Hofmeyr, M., Knight, M., Moodley, Y., Shaw, J., Versteeg, L. ... Mosweu, K. (2024). Risky conclusions regarding shrinking rhino horns. *People and Nature*, 00, 1–4. <https://doi.org/10.1002/pan3.10552>