Received: 18 August 2023 | Accepted: 29 November 2023

DOI: 10.1002/pan3.10584

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

CORRESPONDENCE

Response to 'Risky conclusions regarding shrinking rhino horns': Clarification on a statistically determined reduction of relative horn length in five species of rhinoceros since 1885

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Handling Editor: Maraja Riechers

Abstract

1. In their response to Wilson, Pashkevich, Rookmaaker, et al. (2022), Ferreira et al. argue that our conclusions regarding shrinking rhino horns were risky, given the low sample size used for this assessment, the variation in rhino horn length related to non-heritable factors (including age, sex, environment and behaviour) and the low impact that current selective trophy hunting has on rhino numbers.
2. We agree that our sample size was low and that many factors can influence horn length and therefore we discussed these points as important caveats in Wilson, Pashkevich, Rookmaaker, et al. (2022).
3. However, we argue that although many factors can lead to variation in horn length, they do not explain the decline in relative horn length over time that we observed, and we note that the response does not offer an alternative explanation for this temporal shift.
4. Although selective hunting is currently a minor factor in rhino mortality, this may have been relatively more important and to have had a potentially greater selective influence in the past.
5. Our dataset does not allow identification of factors driving this change, and in Wilson, Pashkevich, Rookmaaker, et al. (2022), we offered selective hunting as one possible explanation for the relative decline, calling for more work to investigate this further.
6. We highlight that the focus of Wilson, Pashkevich, Rookmaaker, et al. (2022) was far more than an assessment of changing relative horn length and instead aimed to demonstrate that a wide range of data can be extracted effectively from image repositories for use in a conservation context.
7. We hope that the results in Wilson, Pashkevich, Rookmaaker, et al. (2022) will provide a useful starting point for future research, including addressing the questions raised by Ferreira et al.

8. Ultimately, we feel that the attention given to Wilson, Pashkevich, Rookmaaker, et al. (2022) reveals the enduring interest people have in rhinos, a topic addressed in other parts of our original paper, which we encourage readers to read in its entirety.

KEYWORDS
Online image repositories, Rhino horn, Rhinoceros

Here we reply to comments from Ferreira et al., regarding interpretations of some results made in Wilson, Pashkevich, Rookmaaker, et al. (2022). We wholeheartedly agree with their response that focussing on the causal reasons for poaching and horn trafficking of rhinos is key to reducing rhino crimes and supporting modern rhino conservation and acknowledge the great importance of active conservation and research that does this, including the work carried out by organisations authoring Ferreira et al.

However, our paper was not focussed on these threats to rhinos. We assessed the use of image repositories for investigating historical changes in species and the interactions between humans and wildlife. The value of such a focus is to increase understanding of long-term changes in species and to contextualise modern conservation action. In particular, as a case study, we used the Rhino Resource Center (RRC), a comprehensive database containing 6415 rhino images and 27,706 pieces of literature (as of 16 August 2023) to assess shifts in human interactions with rhinos over time. We also assessed the extent to which morphological data can be extracted from photographs. As we had an a priori hypothesis that rhino hunting could be selective in the individuals killed, we focussed our morphological analysis on changes in relative horn length over time, predicting that relative horn length would get smaller, matching expectations from other mammals (e.g. Chiyo et al., 2015; Festa-Bianchet et al., 2014).

We found that image repositories represented a rich source of information for studying these different factors. In addition to our findings on changes in rhino representation and human interactions over time, our morphological analyses (which included all five rhino species, not four, as stated in the response) indicated that relative rhino horn length decreased over time, supporting the potential utility of image repositories for these types of investigations. We note that we did not report any value for the extent of this decline, precluded by the methodology we used, and merely outlined the evidence we found for a statistically significant decline in relative length. We agree with the response that there is no empirical evidence to support the claim that hunting is responsible for the decline in horn length over time, and we did not state this. Instead we offered hunting as a possible explanation for the effect we detected, based on comparable results in other mammals (e.g. Chiyo et al., 2015; Festa-Bianchet et al., 2014) and followed up this comment immediately with a call for further research to explore this specifically.

The authors argue that 'the small sample size, with its focus on captive animals … constrains the ability to evaluate the multitude of drivers' that affect rhino horn length. We accept this, which is why we used residuals of the regression of horn length to body length as the response variable and a relatively simple analytical approach to ensure we did not overfit our models. However, we highlight that our conclusions are consistent across statistical approaches. In the original article, we reported that the relationship between these residuals and time was statistically significant ($t=-2.423$, $p=0.0189$, $R^2_m=0.028$, $R^2_c=0.680$), and a re-analysis of our data conducted by an evolutionary ecologist with no connection to our study found that date remained a significant predictor of horn length, after controlling for rhino body size as a fixed effect (Knell, 2022). We also highlighted the small size of our dataset for the morphological aspect of our study (in the abstract and throughout the manuscript) and were cautious in our interpretation, for example, writing that 'It is important to note that the captivity status of individuals in the measured photographs could have influenced our morphological findings' and that 'low sample size of wild rhinos (12 pictures) and rhinos in sanctuaries (3 pictures), and uneven distribution across species (e.g. all 5 photos of Javan rhinos in profile were taken in the wild) precluded statistical testing of the effect of captivity on horn length in this study'. We acknowledge that statistical significance does not necessarily indicate biological significance, particularly when the response variable in our analysis was residual horn length rather than measured horn length itself. We are currently expanding our study to collect data from a wider range of images without the strict criteria imposed in the original study. Preliminary analyses on this much-expanded dataset have yielded generally comparable results to those of Wilson, Pashkevich, Rookmaaker, et al. (2022), and we will share these results (and whether they corroborate the findings of Wilson, Pashkevich, Rookmaaker, et al. (2022)) when we have completed writing the paper.

We agree with the response that there are indeed many environmental factors that could result in variation in relative horn length, not all of which are under selective pressure, and emphasised some of these in the original paper, such as diet and captivity status. We were therefore cautious in presenting our results, writing that we 'found a small but significant decline in relative horn length over time across all species'. and flagging that 'substantially more variation in horn length was attributed to species identity than time'. We welcome the detailed list of factors that could affect the length of rhino horns in the response paper, including behaviour, region, sex and captivity status. However, as far as we can ascertain, the response does not offer an alternative explanation for the observed

decline in horn length over time related to these factors, but rather why we might expect wide variation in horn length (i.e. greater noise in the dataset). Indeed, this variation suggests that such a decline, if present, should be hard to discern, indicating that the pattern we detected may be strong. For instance, while the number of wild rhinos included was low, the proportion of images featuring wild rhinos was not biased towards earlier dates (Wilson, Pashkevich, Rookmaaker, et al., 2022, Supplementary Material 4), potentially suggesting that the pattern was not due to a higher incidence of horn rubbing in captive rhinos. We agree that many factors are likely to be important in explaining variation in horn length within a species, including factors that are likely to be largely environmentally determined (and therefore not heritable) and others which are likely to be largely genetically determined (and therefore heritable). In line with this, the size of horns, tusks and antlers across other trophy-hunted species reflects contributions from both genetic and environmental components (Festa-Bianchet, 2017), and we expect the same to be true for rhinos. To our knowledge, the heritability of horn length has not been categorised for different rhino populations but would lead to a more comprehensive understanding of the drivers of any changes in horn length.

In historical rhino populations, measurement of the effects of some of these factors (e.g. horn rubbing) is not possible, and the low sample size of the morphological dataset in our original study means that individual rhinos may have biased the results. However, an alternative approach to reducing the bias present in the Wilson, Pashkevich, Rookmaaker, et al. (2022) dataset is to expand our sample size to include a greater number of measured rhino horns across time, by relaxing our original selection criteria for inclusion of images. We are currently doing this and look forward to sharing our findings in a publication that is currently in draft.

The response writes 'In practice, selecting rhinos with long horns sufficiently frequently does not occur in rhino populations. The decline in rhino numbers worldwide in the twentieth century is primarily due to poaching, not legal trophy hunting'. We do not dispute that this is currently the case but note that our study is assessing changes over a long time-period (c. 1885–2000 for all species included in morphological components of the study) and therefore may be the result of historical pressures, in line with our study taking a historical perspective. The response writes that our study 'implies that legal trophy hunting was responsible for the shrinkage of horn lengths'. We believe this is a misunderstanding, as we did not mean to refer to modern legal trophy hunting but rather historical hunting pressures (before a ban on hunting was applied, and all hunting was therefore legal). Indeed, accounts from the early 20th century suggest that colonial explorers valued the longest rhino horns (e.g. Ward, 1903), which we predict would result in selective hunting pressure. Therefore, legal hunting could have been more important and have had larger effects in the past and over the long timeframe of our study, especially as rhino populations were much larger (Rookmaaker, 2008) and the effects of selection versus genetic drift on heritable aspects of horn length may therefore have been greater historically.

We agree that 'the most impactful threat to Africa's rhinos continues to be their illegal killing to supply those who traffic their horns', and that 'addressing criminality and transnational organized crime, and the underlying drivers of these activities, is the priority requirement and should be the focus of responsible public debate, policy making, and interventions'. We can understand the authors of the response highlighting this. However, it seems unlikely that discussing historical changes in horn length and perceptions of rhinos in our paper, or indeed the media flagging this, would encourage higher poaching pressure. For example, we were not able to find a study that suggested a link between the well-publicised decline in elephant tusk size reported in African elephants (Chiyo et al., 2015) and increased risk of poaching pressure, but instead found that literature citing this reference focussed on the importance of such insights for future conservation (e.g. Festa-Bianchet, 2017; Hughes et al., 2023; Knell & Martínez-Ruiz, 2017; Lassis et al., 2023; Moller et al., 2019; Palkovacs et al., 2018). We also note that increased media attention on rhinos could be important in raising general awareness of charities involved in rhino conservation, therefore potentially increasing donations or other support. For example, increased media attention has been linked to heightened support for conservation causes (Clements, 2013), and it is important to interact with the public to discuss conservation issues (Novacek, 2008). Since the original publication of our paper, it has been reported on by over 100 news outlets. We took part in nine radio or phone interviews and in at least six, we encouraged the public to support rhino charities, including organisations co-authoring the response. In total, the media coverage of the paper had a combined reach of over 124 million people (estimated from Meltwater media monitoring data), which we hope has increased support for rhino conservation. Finally, we note that it is important for scientific studies to report results consistently from predetermined questions, rather than being selective.

We would like to finish by highlighting to readers the wider findings and conservation implications of our paper, rather than focussing on this one aspect of our results (i.e. changes in horn length over time) and one possible explanation that we offered for it. Key findings from parts of our paper regarding the perceptions of rhinos highlight the particular and enduring fascination that people have for rhinos (sometimes described as 'rhino mania'; Clarke, 1986), which is likely to be key for garnering public attention for their conservation. Collections of images, such as those in the RRC, represent a highly valuable resource for researchers, providing a solid basis to rhino research across a variety of fields (Wilson, Pashkevich, Turner, et al., 2022). The high attention our paper has received also indicates this, emphasising the important role that public awareness has for rhino conservation as it does for other large and charismatic species. We ask readers to read the original paper in its entirety to explore its wider findings.

AUTHOR CONTRIBUTIONS

All authors contributed to the writing of the manuscript and gave final approval before publication.

ACKNOWLEDGEMENTS

We are grateful to the editor and reviewers of the original manuscript for comments that significantly clarified many of the points we repeat here. Thank you to Riitta-Leena Inki for providing Meltwater media reporting information.

CONFLICT OF INTEREST STATEMENT

We declare that both Edgar Turner and Kees Rookmaaker are members of the board of trustees for the Rhino Resource Center.

DATA AVAILABILITY STATEMENT

This manuscript does not include any data.

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REFERENCES

Chiyo, P. I., Obanda, V., & Korir, D. K. (2015). Illegal tusk harvest and the decline of tusk size in the African elephant. *Ecology and Evolution*, *5*(22), 5216–5229.

Clarke, T. H. (1986). *The rhinoceros from Dürer to Stubbs 1515–1799*. Sotheby's Publications.

Clements, C. F. (2013). Public interest in the extinction of a species may lead to an increase in donations to a large conservation charity. *Biodiversity and Conservation*, *22*(11), 2695–2699.

Festa-Bianchet, M. (2017). When does selective hunting select, how can we tell, and what should we do about it? *Mammal Review*, *47*(1), 76–81.

Festa-Bianchet, M., Pelletier, F., Jorgenson, J. T., Feder, C., & Hubbs, A. (2014). Decrease in horn size and increase in age of trophy sheep in Alberta over 37 years. *Journal of Wildlife Management*, *78*(1), 133–141.

Hughes, L. J., Morton, O., Scheffers, B. R., & Edwards, D. P. (2023). The ecological drivers and consequences of wildlife trade. *Biological Reviews*, *98*(3), 775–791.

Knell, R. J. (@robknell1), Twitter. (2022). *Analysis of a historical collection of images of rhinos. The interesting conclusion for me is that relative horn length seems to have declined over time… some thoughts follow.* 2 November 2022. https://twitter.com/RobKnell1/status/1587705462623031298

Knell, R. J., & Martínez-Ruiz, C. (2017). Selective harvest focused on sexual signal traits can lead to extinction under directional environmental change. *Proceedings of the Royal Society B: Biological Sciences*, *284*(1868), 20171788.

Lassis, R., Festa-Bianchet, M., Van de Walle, J., & Pelletier, F. (2023). Genetic rescue from protected areas is modulated by migration, hunting rate, and timing of harvest. *Evolutionary Applications*, *16*(6), 1105–1118.

Moller, R., Cahill, N., & Kimaile, J. K. (2019). The big tuskers of Tsavo: Highlighting the importance of the big tusker project in Kenya's Tsavo conservation area. *International Zoo Yearbook*, *53*(1), 189–199.

Novacek, M. J. (2008). Engaging the public in biodiversity issues. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(Suppl. 1), 11571–11578.

Palkovacs, E. P., Moritsch, M. M., Contolini, G. M., & Pelletier, F. (2018). Ecology of harvest-driven trait changes and implications for ecosystem management. *Frontiers in Ecology and the Environment*, *16*(1), 20–28.

Rookmaaker, L. C. (2008). *Encounters with the African rhinoceros: A chronological survey of bibliographical and iconographical sources on rhinoceroses in southern Africa from 1795 to 1875, reconstructing views on classification and changes in distribution*. Schuling Verlag.

Ward, R. (1903). *Records of big game with the distribution, characteristics, dimensions, weights, and horn & tusk measurements of the different species* (4th ed.). Rowland Ward Limited.

Wilson, O. E., Pashkevich, M. D., Rookmaaker, L. C., & Turner, E. C. (2022). Image-based analyses from an online repository provide rich information on long-term changes in morphology and human perceptions of rhinos. *People and Nature*, *4*(6), 1560–1574.

Wilson, O. E., Pashkevich, M. D., Turner, E. C., & Rookmaaker, L. C. (2022). The Rhino Resource Center: Accessing and utilizing a unique digital database. *Pachyderm*, *63*(63), 190–197.

How to cite this article: Wilson, O. E., Pashkevich, M. D., Rookmaaker, K., & Turner, E. C. (2024). Response to 'Risky conclusions regarding shrinking rhino horns': Clarification on a statistically determined reduction of relative horn length in five species of rhinoceros since 1885. *People and Nature*, *00*, 1–4. https://doi.org/10.1002/pan3.10584