African wild dogs are hot and hungry

Response to Creel et al. (2023)

The accurate identification of threatening processes is an essential component of species conservation; if threats are misidentified, conservation actions unlikely to succeed. For this reason, we welcome Creel *et al.*'s (2023) assessment of prey depletion as a threat to endangered African wild dogs (*Lycaon pictus*). This threat has been repeatedly recognised in wild dog conservation strategies, but identifying the affected populations should help to mobilise targeted and evidence-based conservation action.

We are concerned, however, that Creel *et al.*'s (2023) dismissal of climate change as an additional threat to wild dog populations is based on a misunderstanding of our published findings. Creel *et al.* (2023) argue that "*prey depletion might underlie changes through time in wild dog dynamics that have been attributed to climate change*". However, our multi-site studies did not investigate temporal trends in adult survival (Rabaiotti et al. 2021), and we have repeatedly reported detecting no such trend in reproductive success (Abrahms et al. 2022; McNutt and Gusset 2012; Woodroffe et al. 2017), other than declining pup survival at a single site in Botswana (Woodroffe et al. 2017). Our identification of climate change as a threat is not based upon observed temporal trends in wild dog demography; rather, it is inferred (including through modelling, Rabaiotti et al. in press) from the twin observations that (i) where temperature fluctuates over time, periods of hot weather are associated with lower reproductive success and higher mortality (Rabaiotti et al. 2021; Woodroffe et al. 2017), and (ii) periods of hot weather will become more frequent under climate change.

Creel *et al.* (2023) claim a "*lack of consistency in relationships between temperature and demography*". The paper they cite (Rabaiotti et al. 2021) states explicitly that adult mortality was associated with temperature at only one site. However, in an earlier paper we documented consistently negative associations between pup recruitment and denning period temperature across multiple sites (Woodroffe et al. 2017). Elsewhere, we have argued that widespread seasonal reproduction in wild dogs is an adaptive response to low pup survival in hot weather (McNutt et al. 2019). Associations between temperature and pup survival are thus highly consistent across sites; however, these associations are documented in papers not cited by Creel *et al.* (2023). Ignoring these associations risks compromising wild dog

conservation because, as argued elsewhere, wild dog "*population dynamics are most affected by juvenile survival… thus, juvenile survival should be a focal point for any direct conservation actions*" (Creel et al. 2004).

We also wish to draw attention to anomalies in the Creel *et al.* (2023) paper. Supplementary material and data cited in the text are in fact not provided. Data sources for Figures 1A and 1B are not reported and, as neither of these figures has a scale on the x axis, it is not clear whether these are graphs or infographics. We would have expected such errors, along with the failure to consider relevant literature outlined above, to have been detected and addressed during the publication and peer review process.

In conclusion, we are concerned that Creel *et al.*'s (2023) paper could unintentionally harm wild dog conservation. While we support their identification of prey depletion as an important threat, we are concerned that their dismissal of climate change as a parallel threat (based on a misinterpretation of the evidence) will discourage conservation managers and policymakers from acting to mitigate this threat, increasing the risks of local and regional wild dog extinction.

Literature Cited

Abrahms, B., Rafiq, K., Jordan, N.R., McNutt, J.W., 2022. Long-term, climate-driven phenological shift in a tropical large carnivore. Proceedings of the National Academy of Sciences 119, e2121667119.

Creel, S., Becker, M., Reyes de Merkle, J., Goodheart, B., 2023. Hot or hungry? A tipping point in the effect of prey depletion on African wild dogs. Biological Conservation 282, 110043.

Creel, S., Mills, M.G.L., McNutt, J.W., 2004. Demography and population dynamics of African wild dogs in three critical populations, In The biology & conservation of wild canids. eds D.W. Macdonald, C. Sillero-Zubiri, pp. 337-350. Oxford University Press, Oxford.

McNutt, J.W., Groom, R., Woodroffe, R., 2019. Ambient temperature provides an adaptive explanation for seasonal reproduction in a tropical mammal. Journal of Zoology 309, 153-160.

McNutt, J.W., Gusset, M., 2012. Declining body size in an endangered large mammal. Biological Journal of the Linnean Society 105, 8-12.

Rabaiotti, D., Groom, R., McNutt, J.W., Watermeyer, J., O'Neill, H.M.K., Woodroffe, R., 2021. High temperatures and human pressures interact to influence mortality in an African carnivore. Ecology and Evolution 11, 8495–8506.

Rabaiotti, D., Woodroffe, R., Coulson, T., in press. Climate change is predicted to cause population collapse in a cooperative breeder. Global Change Biology https://doi.org/10.32942/osf.io/snpuf.

Woodroffe, R., Groom, R., McNutt, J.W., 2017. Hot dogs: high ambient temperatures influence reproductive success in a tropical mammal. Journal of Animal Ecology 86, 1329-1338.