Animal Conservation

Animal Conservation. Print ISSN 1367-9430

RESPONSE

Grevy's zebra conservation: overcoming threats of isolation, genetic hybridization and demographic instability

J. E. Cordingley[1,2], S. R. Sundaresan[2,3,4], B. J. Larison[5], B. Shapiro[6] & D. I. Rubenstein[2,4]

1 Centre for Conservation Ecology and Environmental Change, School of Conservation Sciences, Bournemouth University, Dorset, UK
2 Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA
3 Department of Conservation Biology, Denver Zoological Foundation, Denver CO, USA
4 Mpala Research Centre, Nanyuki, Kenya
5 Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA, USA
6 Department of Biology, The Pennsylvania State University, University Park, PA, USA

Correspondence
Justine E. Cordingley, Centre for Conservation Ecology and Environmental Change, School of Conservation Sciences, Bournemouth University, Talbot Campus, Poole, Dorset BH12 5BB, UK.
Email: justine.cordingley@gmail.com

doi:10.1111/j.1469-1795.2009.00336.x

Thousands of years ago, equids were one of the most abundant herbivores on the plains of Africa and Asia. Now only seven species remain: one of which is vulnerable, three of which are classified as endangered or critically endangered and one of which is extinct in the wild (Moehlman, 2002). For the latter five species, population declines have been related to human driven factors, such as hunting and competition with livestock. Within at least two of these species, population declines have resulted in such low genetic diversity within their population that this factor alone threatens their long-term persistence. For these species, researchers have proposed management programmes that, first and foremost, concentrate on trying to increase genetic variation within subpopulations through active management (Smith *et al*., 2007). Often, even if the original drivers of population decline are stopped, small, isolated populations have suffered such a reduction in genetic diversity that they can still be at risk of extinction (Spielman, Brook & Frankham, 2004). Grevy's zebra *Equus grevyi* are estimated to have declined by 75% since the late 1970s (Williams, 2002). The remaining populations are becoming increasingly isolated, especially in the northern part of their range. It is very likely that both the recent population decline and increasing isolation will have had a negative effect on their genetic diversity (Hill, 2009). As the commentaries on our study suggest, it is essential to establish levels of genetic variation between and within subpopulations of Grevy's zebra. It has been suggested that small populations of Grevy's zebra could be bolstered with individuals from larger populations (Kenya Wildlife Service, 2008). Currently there is no genetic data on which to base translocation decisions. Taking individuals from a few large populations could lead to the situation Hill (2009) described for Cape mountain zebra *Equus zebra zebra*, although the total Grevy's zebra population is not nearly as small. Determining genetic variation within Grevy's zebra populations could prevent a similar situation from developing. Such data could also identify populations that are currently at risk for isolation effects (Schwartz, Luikart & Waples, 2007). In a collaboration between Denver Zoo and molecular ecologists at the University of California, Los Angeles, the process of documenting the genetic variation within the species has already begun. Between June and August 2009, 10 populations within Kenya were sampled with the eventual aim of sampling nearly every population in Kenya.

While all the commentators agree that removing hybrids would be unnecessary, they have also stressed the need to establish whether the plains zebra *Equus burchelli* mtDNA found in two Grevy's zebra females is the result of a sampling error or is representative of backcrossing. While it is unlikely that this mtDNA is a result of plains zebra males mating with Grevy's females, Chiyo & Alberts (2009) outline a scenario that could explain how the unidirectional hybridization we described (Cordingley *et al*., 2009) may have led to plains mtDNA in Grevy's zebra. Since the Grevy's population in our study are thought to have only moved into the area during 1992, we believe that there may not have been enough time for this situation to arise. However, more intensive sampling of the Grevy's zebra within the study area will allow us to determine whether backcrossing has occurred.

If Grevy's populations were to become smaller, more isolated and increasingly concentrated further south (all factors which would increase their contact with plains zebra)

the occurrence of hybridization could increase. Each occurrence would be context specific and the factors leading to hybridization and the threat it poses to Grevy's zebra would need to be determined in each situation (Genovart, 2009). Measures could then be put in place to prevent it from occurring again where necessary. Monitoring to identify whether hybridization is occurring elsewhere is ongoing. The wider genetic study proposed above will also enable us to delve deeper into the recent evolutionary history of these two species to determine if any hybridizations have taken place in the past as species ranges expanded and contracted (Ryder & Steiner, 2009). Other, more urgent threats, such as competition of Grevy's zebra with livestock for grazing and water, require our primary attention. The drought in Kenya throughout 2009 has only increased these pressures, while adding additional ones, such as disease (Muoria *et al*., 2007). While it is not going to be easy to address these issues, we believe that community conservancies in the north of Kenya hold some promise in providing 'protected' areas for Grevy's zebra (Low *et al*., 2009). We will need to monitor vital rates within different Grevy's zebra populations to determine where and why population growth is or is not occurring. In addition, once we have data on the genetic variation within the population we will be able to assess the level of threat isolation poses to the long-term persistence of the species.

Acknowledgements

We would like to thank P. Chiyo, S. Alberts, R. Hill, O. Ryder and C. Steiner for their thoughtful comments about the situation we described in our featured paper and their advice on future research directions. We would also like to thank L. Haines, L. DaVolls and J. Gall for their assistance in the publishing process.

References

Chiyo, P.I. & Alberts, S.C. (2009). An assessment of the threat to Grevy's zebra from hybridization. *Anim. Conserv*. **12**, 514–515.

Cordingley, J.E., Sundaresan, S.R., Fischhoff, I.R., Shapiro, B., Ruskey, J. & Rubenstein, D.I. (2009). Is the endangered Grevy's zebra threatened by hybridization? *Anim. Conserv*. **12**, 505–513.

Genovart, M. (2009). Natural hybridization and conservation. *Biodivers. Conserv*. **18**, 1435–1439.

Hill, R. (2009). Is isolation the major genetic concern for endangered equids? *Anim. Conserv*. **12**, 518–519.

Kenya Wildlife Service. (2008). *Conservation and management strategy for Grevy's zebra (Equus grevyi) in Kenya 2007–2011*. Kenya: Kenya Wildlife Service.

Low, B., Sundaresan, S.R., Fischhoff, I.R. & Rubenstein, D.I. (2009). Partnering with local communities to identify conservation priorities for endangered Grevy's zebra. *Biol. Conserv*. **142**, 1548–1555.

Moehlman, P.D. (2002). *Equids: zebras, asses, and horses: status survey and conservation action plan*. Gland: IUCN/SSC Equid Specialist Group.

Muoria, P.K., Muruthi, P., Kariuki, W.K., Hassan, B.A., Mijele, D. & Oguge, N.O. (2007). Anthrax outbreak among Grevy's zebra (*Equus grevyi*) in Samburu, Kenya. *Afr. J. Ecol*. **45**, 483–489.

Ryder, O.A. & Steiner, C.S. (2009). How much hybridization and in what direction? *Anim. Conserv*. **12**, 516–517.

Schwartz, M.K., Luikart, G. & Waples, R.S. (2007). Genetic monitoring as a promising tool for conservation and management. *Trends Ecol. Evol*. **22**, 25–33.

Smith, R.K., Marais, A., Chadwick, P., Lloyd, P.H. & Hill, R.A. (2007). Monitoring and management of the endangered Cape mountain zebra *Equus zebra zebra* in the Western Cape, South Africa. *Afr. J. Ecol*. **46**, 207–213.

Spielman, D., Brook, B.W. & Frankham, R. (2004). Most species are not driven to extinction before genetic factors impact them. *Proc. Natl. Acad. Sci. USA* **101**, 15261–15264.

Williams, S.D. (2002). Status and action plan for the Grevy's zebra (*Equus grevyi*). In *Equids: zebras, asses and horses: status survey and conservation action plan*: 11–27. Moehlman, P.D. (Ed.). Gland: IUCN/SSC Equid Specialist Group.

