Title:

Promoting ex-situ management risks being a dangerous and costly distraction from conserving species in the wild: Response to Farhadinia et al. 2020

Article:

Conservation of endangered species may include establishing ex-situ populations to provide insurance against extinction in the wild. Farhadinia et al. (2020) looked at the use of ex-situ management for 43 species, subspecies and subpopulations of mammalian megafauna, finding that approximately a third of these taxa currently have no ex-situ populations and for 23% that do, the ex-situ population is not currently viable. They argue that bringing these species, particularly those found in "politically unstable" regions, into captivity should be "considered more rigorously".

Whilst we agree that, in certain cases, ex-situ management can provide an important safety net to prevent species extinctions, it is not a panacea. Negative conservation impacts may arise throughout the establishment of ex-situ populations, and species-specific biological factors influence whether ex-situ management (and ultimately reintroduction/reinforcement) is appropriate. Although these considerations should be central to decisions about initiating ex-situ management, they were disregarded by Farhadinia et al. Here, we address this gap and identify issues that may arise during the establishment, management, and release of ex-situ populations.

Initiating captive populations

Of 43 taxa included in the original paper, 15 were assessed as having no ex-situ management, with a further 10 where their current ex-situ population is too small to avoid risks of inbreeding depression. Consequently, effective ex-situ management of these 25 species would require individuals to be captured from wild populations. Farhadinia et al. used an effective population size of >50 individuals to indicate a viable population, without considering the difference between actual population size (N) and effective population size (N_e) in captive populations. The average ratio of N:N_e is 0.26 (max 0.7; Lees & Wilcken 2009), for an N_e of 50, the ex-situ population would need 70 – 190 individuals; therefore, at least 5 additional taxa do not currently have sustainable captive populations. For half of these 30 taxa, creating a sustainable ex-situ population would require capturing 50% to 100% of their wild population. When wild populations are very small, as is the case for many Critically Endangered (CR) taxa, they are vulnerable to stochastic events and inbreeding depression. Therefore, removing enough individuals from these populations to avoid inbreeding in ex-situ populations poses an additional threat to their survival in the wild, and in the case of some CR taxa, would make them extinct in the wild, as was the case for red wolf (*Canis rufus*; Hinton et al. 2017).

The practicality of establishing effective ex-situ populations in "politically unstable" regions is another key concern. Ex-situ management is substantially more expensive than in-situ management (Balmford et al. 1995) and many countries have insufficient resources to effectively manage and maintain captive populations, especially during armed conflicts where local resources and foreign aid are likely to be diverted elsewhere. Moving endangered species to other countries can be appropriate and effective when undertaken in collaboration with range governments and wildlife authorities. However, amidst political turmoil and/or periods of unrest, these agencies are likely to be stretched in their capacity to adequately engage with these initiatives; removing biodiversity under such circumstances may raise legitimate allegations of exploitation and neocolonialism (Hayward et al. 2018).

Maintaining a captive population

Ex-situ management is extremely complex, with species often having complicated husbandry requirements for survival, health, and reproduction. These requirements are usually identified over many years of experience in captive management, often through trial and error. For example, although all female cheetahs (*Acinonyx jubatus*) breed in the wild (Laurenson et al. 1992), a substantial proportion do not successfully breed in captivity, even when kept in optimal conditions (Wachter et al. 2011). Thus ex-situ management is unlikely to serve as comprehensive insurance for two CR subspecies of cheetah (*A. j. hecki* and *A. j. venaticus*), particularly as moving individuals into captivity will reduce their effective population size and further threaten their viability in the wild.

Difficulties in providing appropriate conditions to foster natural behaviour and reproduction in captivity hinders the maintenance of genetic diversity. Moving large mammals between institutions for breeding has welfare implications and is very expensive, with no guarantee of successful reproduction. Assisted reproduction is becoming more widely used but it is an invasive, expensive procedure which is, for many endangered species, untested and experimental (Weise et al. 2014).

Reintroduction/reinforcement

The ultimate objective of ex-situ conservation should be reintroduction/reinforcement of wild populations, however preparing animals for release is a complicated process particularly for species, such as large carnivores, that rely on complex and learned behaviours to survive in the wild. Young predators learn many of their skills from their mothers; whilst some hunting related behaviours may be innate, predator and human avoidance behaviours are usually learnt (e.g., in cheetahs; Durant 2000), yet have a direct impact on the likelihood of an animal surviving post-release (Tetzlaff et al. 2019). Training animals to hunt and forage effectively in a captive setting is difficult, time-consuming, and expensive, with no guarantee of success. In addition, reintroductions ultimately depend on the timely cooperation of ex-situ institutions making their, often valuable, captive populations available for release into the wild, which is not guaranteed.

Finding suitable areas for release is also challenging, particularly when concurrent in-situ conservation efforts are absent or limited, as the original threats to the species may persist. Reinforcing extant populations with captive individuals will put additional pressure on available resources, and may result in intraspecific competition (Hayward et al. 2007), exacerbate human-wildlife conflict and erode potential goodwill (Qin et al. 2015). Equally, if the species has been extirpated at reintroduction sites, then local human populations may have lost coping mechanisms for living alongside the species leading to human-wildlife conflict (Linnell & Cretois 2018).

Additional considerations

Several inconsistencies in the approach used by Farhadinia et al. are cause for concern. Most importantly, their "43 critically endangered species" includes some subspecies, but not others (e.g., all subspecies of *Gorilla beringei* and *Gorilla gorilla* were included but not all subspecies of *Pongo pygmaeus*); as well as two subpopulations, which are not recognised as subspecies (the West African subpopulations of the African wild dog (*Lycaon pictus*) and the African lion (*Panthera leo*)). These inconsistencies have a substantial impact on the figures reported in the paper, depending on which definition of (sub)species is used (Table 1; Appendix Table S1).

The existence of armed conflict within a species range was suggested as a reason for implementing ex-situ management. However, as acknowledged in the original paper, periods of conflict do not inevitably lead to conservation harm (Collar et al. 2017). Using conflicts to justify diverting funding from in-situ conservation towards ex-situ management is clearly inappropriate. Likewise, the paper claims that border zones can compromise conservation, but there is no justification given for this generalisation. For 15 taxa, having transboundary ranges was the sole indicator of "political instability" (Table 1), but no evidence was provided showing they are at greater risk because of this. It should also be noted that ex-situ populations are also susceptible to political instability, with captive animals vulnerable to being mistreated and/or killed (Kinder, 2013).

Conclusion

Farhadinia et al. suggest using "ex-situ management as an insurance against extinction", but insurance does not always pay out: for example the northern white rhino (*Ceratotherium simum cottoni*) is effectively extinct in the wild despite years of intensive ex-situ management, costing substantial amounts of money (Gibbens 2018).

Whilst we agree that ex-situ management can be an important aspect of species conservation, which has been effective for certain species, its use should be considered on a species-by-species basis, incorporating biological, ecological and socioeconomic information rather than broad-stroke generalisations based on threat levels and inferences about range country governance. The difficulties associated with ex-situ management and reintroduction/reinforcement discussed here are not exhaustive, with multiple species-specific issues affecting different taxa. Such difficulties may explain why very few of these species have been the subject of successful releases.

Ex-situ management is very resource intensive and often depletes limited in-situ resources and efforts, with no guarantee of success, particularly for species with complex behaviours and/or threats. Where sufficient species-specific data are available, robust decision trees, using input from a range of stakeholders and experts, can be useful tools for determining whether ex-situ management may be appropriate (e.g., Canessa et al. 2016). The five-step process proposed by IUCN Species Survival Commission (IUCN SSC 2014) provides best practice guidelines on when ex-situ management is likely to augment conservation efforts, but mammalian megafauna (especially large carnivores) often do not meet these conditions due to their intrinsic characteristics.

Generalised endorsement of ex-situ management as an insurance against the extinction of megafauna, in the absence of more pragmatic recommendations, risks being an expensive distraction from addressing the real threats faced by many species in the wild. We, therefore, argue that in-situ conservation should remain the primary focus of species conservation; ex-situ management as a tool to recover a species should only be initiated as a last resort after using IUCN SSC best practice guidelines.

Supporting Information

Detailed species data (Appendix S1), Notes on the inconsistencies observed in species data from Farhadinia et al. 2020 (Appendix S2) are available online. Authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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Tables

Table 1. Differences in the figures obtained based on the species definition used. (ssp: subspecies). Alternative's detailed data are available in Supporting Information.

	From Farhadinia et al. 2020: includes some Recognized ssp, but not all and subpopulations that are not recognised ssp	**Alternative 1:** Recognized ssp used where possible, if no Red List entry for the ssp then the parent species Red List is used	**Alternative 2:** Recognized ssp used where possible, if no Red List entry for the ssp then it is inferred from information in the parent species Red List	**Alternative 3:** Exclude all ssp, use only the Red List entry for parent species
Number of taxa	43	38	42	21
Number of range countries	54	49	55	32
Number of taxa with total in-situ population <250	24	20	22	8
Number of taxa with total in-situ population >1000	8	9	9	7
Percentage of taxa where population trend is decreasing	86.05	86.84	80.95	90.48
Percentage of taxa where ranges cross national boundaries	48.84	42.11	38.1	38.1
Percentage of taxa with armed conflict in range	30.23	28.95	28.57	28.57
Number of taxa with no ex-situ population – international	23	19	21	9
Number of taxa with no ex-situ population – national	15	12	13	6

Percentage of taxa with no ex-situ and ranges crossing international boundaries & conflict zones	73.33	66.67	75	57.14
Percentage of taxa with no ex-situ and ranges crossing conflict zones	26.67	25	33.33	14.29