Effects of captivity and implications for _ex situ_ conservation: with special reference to the red panda (_Ailurus fulgens_)


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ABSTRACT
This PhD thesis aims to improve the ex situ conservation of threatened and endangered species by investigating the effects of captivity and improving the methodology of current conservation techniques. The use of reintroduction as a tool for the purpose of conserving species is becoming increasingly popular. Since many wild populations are declining, captive-bred stock are frequently used to restore or supplement wild populations. Evidence suggests that captive-bred animals are less successful than their wild counterparts, but this has not been recently reviewed and there is limited research into investigating what aspects of captivity may be affecting success. Here, I conduct a review of carnivore reintroductions for projects carried out post 1990, which shows that captive-born animals are less likely to survive a release into the wild than their wild-caught translocated counterparts. A case study species, the endangered red panda (Ailurus fulgens), is used to investigate how a species involved in captive breeding for conservation responds to life in captivity. Results from analyses of lifetime reproductive success (and related variables) showed that both adaptation to captivity and inbreeding depression are occurring in the global captive red panda population. An investigation into behavioural adaptation to captivity was less revealing, although only generations three to seven from the wild were observed. The effects of captive environment and husbandry regime were also investigated and revealed that the size of the useable area and amount of human contact were among the factors influencing the behaviours of red pandas. How these findings contribute to a greater understanding of effects of captivity is discussed. The use of selection criteria based on temperament was also investigated in order to improve the likelihood of survivorship upon release into the wild. This method needs to be tested in practice, but based on the selection criteria used, there was evidence that unsuitability for release was positively predicted by generation time in captivity. Implications for the future use of captive red pandas in efforts to conserve the species in the wild are discussed, as well as how these findings can be utilised for other species involved in conservation efforts.

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STATEMENT OF THE CANDIDATE’S CONTRIBUTION TO CO-AUTHORED PAPERS
There are five studies included in this thesis, three of which have been written up as manuscripts for publication. As detailed below, the substantial contribution to the co-authored papers presented in this thesis was made by the candidate. However, while the candidate is fully responsible for the work presented in this thesis, where the first person is used it is in the plural (i.e., ‘we’ rather than ‘I’) as in the original peer-reviewed articles, to reflect the collaborative efforts guiding the research process. All chapters that have been written up as manuscripts are presented in the format requested by the respective journal; since each manuscript is meant to stand alone, some information may be redundant.

**Paper 1: Chapter 2**


The first manuscript, presented in this thesis as Chapter 2, was submitted as a paper to the journal *Biological Conservation* and was accepted in November 2007. The data were collected and analysed by the candidate, with statistical advice from Prof. Stephen Lea. The paper was written with supervisory support from Dr. Lisa Leaver and Prof. Stephen Lea.

**Paper 2: Chapter 3**

The second manuscript, presented in Chapter 3, was submitted to the journal *Animal Behaviour* but was not deemed novel enough. It is currently in preparation for submission to *Behaviour*. The candidate designed the methodology of data collection as well as collected and analysed the data. Prof. Stephen Lea contributed to the model equation and the theoretical application of the model. The paper was written with supervisory support from Dr. Lisa Leaver and Prof. Stephen Lea.

**Paper 3: Chapter 6**


The third manuscript, presented in Chapter 6, was submitted to the journal *Animal Conservation* in April 2008. The candidate designed the questionnaire, collected the data, analysed the data and wrote the paper with supervisory support from Dr. Lisa Leaver and Prof. Stephen Lea.

**STATEMENT OF THE SUPERVISORS’ CONTRIBUTION TO CO-AUTHORED PAPERS**

As outlined in the candidate’s statement above, the substantial contribution to the co-authored papers presented in this thesis was made by the candidate. This includes the review of the literature presented in each paper, study design, statistical analyses and interpretation of the data, together with the write-up for publication. The supervisors
contributed to the papers by advising on statistical analyses and interpretational issues, relevant literature, and writing style. Moreover, the theoretical framing of the empirical work in this thesis and the arrangement of the papers is a product of a concerted discussion of the thesis content between the candidate and supervisors.

Dr. Lisa A. Leaver (first supervisor)

Prof. Stephen E. G. Lea (second supervisor)