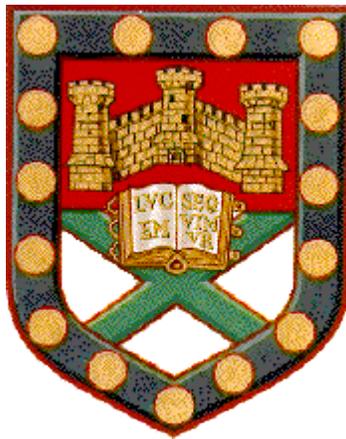


**Effects of captivity and implications  
for *ex situ* conservation: with special reference to the red panda  
(*Ailurus fulgens*)**



Submitted by Kristen Rebecca Jule to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Animal Behaviour, May 2008.

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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.

## **ACKNOWLEDGEMENTS**

I would first like to thank my supervisors, Dr. Lisa Leaver and Prof. Stephen Lea, without their support, encouragement, and understanding (as well as an extremely large amount of patience), I would never be where I am today. I would especially like to thank Lisa, an expert on the caching behaviours of rodents, who took a great risk by agreeing to supervise a girl wanting to study carnivores in captivity. Thank you so much for the freedom to pursue a research topic that was very important to me; you have truly provided me with the most amazing opportunity. I would also like to express my gratitude to Stephen, who despite his many hats in the department, always made time to answer any and all mundane questions I had; your brain holds a fountain of knowledge that I have always treasured. Additionally, the extra time you spent creating a programme that turned the historical studbook pdf file into something usable was above and beyond the call of duty – many thanks for that. Thank you both for your guidance and assistance throughout.

I have many friends who have been instrumental in supporting me throughout my PhD. Mette Hersby, my friend, my lifeline, I am so thankful to have had you by my side every step of the way. Thank you to my officemates, Dimitrios Tsivrikos and Ivonne Hoeger, who have put up with me and helped to make this writing up year bearable - you have my immense gratitude. Fiona Neligan and the rest of the office and support staff – a great big Thank You. There are many other members of the department who have helped to make the PhD experience so worthwhile, and just because I cannot list everyone here does not mean that I value their contribution to my sanity any less. To my friends outside of academia who have also helped to keep me sane: Anouska Bell, Morag Verhoeve – my long-suffering housemate and the Smail family – who have provided me with the best home anyone could ask for – thank you.

I would like to thank my parents, Joan and Ron, and my brothers, Kyle and Brett, who may not have always understood what has driven me, but who have always accepted me as I am and have always been supportive of my dreams. Without their emotional and financial support, accomplishing this thesis would never have been possible.

And lastly, to my best friend, the only one who has truly been with me from the beginning of this journey on the other side of the Atlantic Ocean – my dog, Sequoyah. This is my humble attempt to ensure that your kind will always grace the earth with your presence. For what would humans do if the last animal were to fall? If all my human acquaintances loved as unconditionally as you, this world would hold unimaginable joy.

**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

Jule, K. R., Leaver, L.A., & Lea, S.E.G. (2008). Effects of captive experience on reintroduction survival in carnivores: A review and analysis. *Biological Conservation* 141(2), 355-363.

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

Jule, K. R., Lea, S.E.G., & Leaver, L. A. (in prep.). Using a behaviour discover curve to predict optimal observation: captive red pandas (*Ailurus fulgens*) as a case study.

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

Jule, K. R., Lea, S.E.G., & Leaver, L. A. (under review). Examining the use of behavioural assessment in captive-born animals to identify temperament traits associated with reintroduction success. *Animal Conservation*.

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)