

**Wild Horse Welfare:  
Assessment and associations with  
population and behavioural ecology**

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**BVSc DSAM (Fel) DipECVIM-CA MRCVS MANZCVS (Animal Welfare)**

A thesis submitted in fulfilment of the requirements for the  
degree of

**Doctor of Philosophy**

Under the supervision of Daniel Ramp, Rosalie Chapple, and  
Fiona Hollinshead

Faculty of Science  
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# Certificate of Original Authorship

I, Andrea Harvey, declare that this thesis is submitted in fulfilment of the requirements of the award of Doctor of Philosophy, in the School of Life Sciences, Faculty of Science at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Date: December 23, 2021

## Acknowledgements & Preface

My PhD candidature and this thesis are only a small part of a long and hectic journey fully immersed in the world of 'brumby' health and welfare. I feel that it is important to say a few words about my broader story to provide a context for where this thesis fits in. It is hard to separate out my PhD from the rest of my life during my 6 year candidature, as it has all been closely intertwined, with every aspect of my immersion in this field influencing my ideas and thought processes throughout my PhD work.

I use the colloquial name here for Australian wild horses, 'brumby', because whilst my thesis focuses on the scientific assessment of the health and welfare of free-roaming wild horses, my life during this time has been dedicated to all aspects of 'brumby' welfare in many different settings from the wild to the transition into domestic lifestyles, and their training, husbandry and healthcare within domestic environments. Everything that I have learnt about, and learnt from, these horses, once in captivity, has also enhanced my understanding and knowledge of them, and inspired ideas with respect to researching them in the wild, and vice versa. An article that I wrote for the Centre of Veterinary Education's Control & Therapy series (Appendix 1) tells the story of how, as a UK small animal internal medicine specialist veterinarian, I came to start this journey with Australian wild horses, and a later article in Horse & People magazine (Appendix 2) briefly summarises much of my story working with brumbies, to date, in addition to aspects of my research that I have not included in this thesis.

My wider work in this field is also relevant to the large number of acknowledgements that I need to give. Whilst the PhD itself has often been a very lonely journey, there are a huge number of people that I have met through this work, who have inspired me, motivated me, reignited my passion when it has been waning, shaped my journey, matured my character, challenged my intellect, and enriched my life in so many ways.

My thanks has to both start and finish with my partner, Richard, without whom I would never have had the life that inspired and enabled this journey. Nor would I have been brave enough, at a mature age, to take a break from my well-established career as a small animal internist, and embark on a journey with wild horse ecology research and animal welfare science, let alone enrol for a PhD in the area. I certainly wouldn't have completed this PhD without Richard's unfailing support in every aspect. Even during Richard's many periods of illness and throughout several stints

in hospital, his priority has always been that I keep working on my PhD. During his most recent hospitalisation only a few weeks ago, he managed, from his hospital bed, to still continue nagging me to keep writing! Richard has also encouraged, facilitated, and supported the development of our own brumby sanctuary striving to demonstrate gold standard welfare practices (Figure 1), and the expansion of my skill set in aspects of equine medicine, anaesthesia and surgery to enable me to better manage the healthcare of brumbies in domesticity. Richard also supported me studying for Australian & New Zealand College of Veterinary Science Membership examinations in Animal Welfare which I did alongside field work in the first year of my candidature. I could not have done any of this without Richard's financial support. The funding available for research into the welfare of a non-native species is virtually non-existent. I also had a strong desire to undertake completely independent research where no claims could be made of research bias as a result of a funding agency. As such, all my research has been completely self-funded, other than my Australian Government Research Training Program and University of Technology Sydney Chancellor's Research scholarships.



**Figure 1. (a)** Our farm in rural New South Wales that gradually became a brumby sanctuary during my PhD candidature; **(b)** Richard with 'Gertie' the goat, and 'Apache' a rescue pony.

As a boarded Specialist veterinarian, I also have an obligation to maintain credentials through ongoing clinical work, teaching, and publications in this field. Juggling these commitments was challenging, and I have to thank all my small animal medicine colleagues for their patience and understanding during these works when my mind was often on horse welfare or drifting around somewhere in the middle of the Australian Alps.

Sincere thanks to Jan Carter of Save the Brumbies Inc. (Figure 2) who first introduced me to brumbies and encouraged and facilitated me to start some immunocontraceptive trials. Stephen Page was also instrumental in assisting with planning these trials as well as later on providing practical support in field work. Whilst my immunocontraceptive work hasn't ended up being incorporated into my thesis, this was the initial inspiration for pursuing research in wild horses and was the focus of several conference presentations, also leading to an ABC news article and an article in The Conversation (<https://theconversation.com/hold-your-horses-brumby-fertility-control-isnt-that-easy-97313>).



(a)



(b)

**Figure 2.** (a) Jan Carter first introduced me to brumbies and facilitated my initial immunocontraceptive trials; (b) Injecting a brumby with a GnRH immunocontraceptive vaccine at Save the Brumbies sanctuary near Armidale, northern NSW.

To my primary supervisor, Daniel Ramp, who, during a chance meeting, managed to persuade me to turn this 'hobby' into a PhD candidature. Dan insightfully recognised the need for collaboration between the fields of animal welfare science and ecology, and encouraged me to bring my existing skill set into this domain, and to expand my skills by exploring ways of scientifically assessing the welfare of free-roaming wild animals. I am grateful to Dan for the autonomy he allowed me in shaping my own journey, and his ongoing support. Thanks also to UTS colleagues, Finbarr Horgan and Caitlin Austin for the moral support and friendship, and Esty Yanco for invaluable assistance with thesis formatting and encouragement during the final stages of writing.

The socio-politically contentious nature of wild horses makes everything about wild horse research challenging. I have to thank my co-supervisor Rosalie Chapple for her

wisdom early in my candidature, in advising me on negotiating the political side of wild horse research. I also value the time Rosalie spent with me in the field, and the many chats and sage advice that arose whilst hiking through the bush. Thanks also for being instrumental in all the background work that created the possibility for horse research in Kedumba Valley, which is what provided me with the opportunity of a field based PhD project in this area.

To my other co-supervisor, friend and confidante, Fiona Hollinshead, for giving me unfailing moral support, for always believing in me, enabling me to see the positives in a bad situation, and always motivating me to keep me going, even during the darkest of times. The tragic loss of Fiona's husband, Dave Hanlon, in a fatal car accident was the most devastating event during my candidature. Dave was also a valuable and inspiring mentor in the equine reproduction components of my research, always providing constructive advice regarding my immunocontraceptive studies, and welcoming me to spend time with him in his practice in New Zealand, a time that I will always cherish. Dave also advised me on using the 'Henderson method' for gelding horses, a technique that I have now performed in well over 100 brumby stallions, a significantly higher number of mature stallion geldings than is reported in the current literature to date. This has been a life saver for these stallions that are often slaughtered in knackeries and abattoirs, partly due to the practical difficulties and costs associated with gelding, and challenges of housing and handling them until this time, before they can be rehomed. Whilst this work hasn't been included in my thesis, I consider these important aspects of my broader work into improving welfare outcomes in the management and rehoming of wild horses. There is more information on this work in Appendices 3 (gelding brumbies) and 4 (welfare issues with horse slaughter), in addition to being an important part of my ongoing work, detailed in Chapter 9.

Through the gelding and other pro-bono brumby veterinary work that I have done throughout my candidature, I met my now life friends, Alison Wardman and Kim Bensch, which has been a highlight of this journey. A long road trip with Alison to an outback sheep station in far west NSW, where a large brumby training and rehoming centre had been developed, was the beginning of biannual trips with Kim to geld brumbies. We managed to pick up an exceptional assistant along the way, Cath Healy (Figure 3), who has become an instrumental member of our gelding team always happy to travel anywhere at short notice to assist us and take vigilant anaesthetic records. I am so grateful to Cath's loyalty and dedication. Enormous thanks especially



to Kim for unfailing support with all aspects of brumby veterinary work, for teaching me so much, always being there as a sounding board, and always jumping in to provide practical assistance. This work inspired me to establish an organisation 'Brumby Vet', and a state of the art wild stallion rehabilitation centre on our property. With Kim's particular expertise in equine dentistry, I must also thank her for all her time examining wild horse skulls to evaluate age at death from the dentition, and record any dental pathologies.



**Figure 3. (a)** Brumby stallions in Outback Australia waiting to be gelded; **(b)** Gelding brumby stallions with Alison Wardman, Kim Bensch and Cath Healy.

The broad multidisciplinary nature of my project made good collaborators critical to its success. Huge thanks to Jan Slapeta at University of Sydney, for warmly welcoming me into his parasitology lab, generously giving his time to teach me practical techniques, and his infectious enthusiasm for parasitology. Paul Canfield and Mark Westman were also treasured sounding boards at various stages.

It has been an enormous honour to have the wisdom, support and friendship of one of the greatest minds and 'godfathers' of the discipline of animal welfare science, Professor Emeritus at Massey University, David Mellor. David is truly like a rare diamond, possessing a unique combination of amazing intellect, insightful life experiences, deep wisdom, and exceptional kindness, patience and generosity. Particularly throughout the last year of writing, David frequently called me on the phone, sometimes just to check that I was OK, other times to offer positive and motivating comments, or to congratulate me on the metrics of my last paper and insist that I celebrate, and mostly to instil his wise thoughts into my writing. It was really David's faith in me that kept me writing in the final year when I often lost confidence

in my work and on occasion felt like giving up. Even in his well-deserved retirement whilst having his own new projects of writing books based on his life journeys, creating Haiku-Senryu poems, and playing golf, he would always take time to discuss my work or read drafts of chapters, always with great attention to detail, positive words, and sage advice. Words cannot express the immense gratitude that I have for David's advice, support and friendship.

Sincere thanks also to Ngaio Beausoleil, at Massey University, for always taking time within her own busy research and teaching schedule to enthusiastically, thoughtfully and encouragingly discuss my work, always offering so many valuable insights. The first time that I met Ngaio during a visit to Massey early in my candidature, she didn't hesitate to warmly welcome me to stay in her home for a few days with her lovely family. The warmth and generosity, in addition to academic support is so much appreciated. Ngaio also provided me with many opportunities for sharing my work at conferences and in workshops. It was a particular honour to co-author the seminal paper on Conservation Welfare, with a prestigious group of co-authors, led by Ngaio (Appendix 5).

Heartfelt thanks to Catherine Butler and Elyssia Watts from the University of Tasmania, and their supervisory team, for warmly welcoming me to collaborate with them on work in the Australian Alps. 'Cat' and 'Talsy' made this period of work productive and enjoyable, and I will always treasure all our time together in the field (Figure 4). Through many long hours observing horses, collecting faecal samples, getting rained out of swags and recovering bogged vehicles, we were never short of laughs and I made more life friends. I was also proud to be a co-author on Elyssia's honours paper (Appendix 6). Again, although most of my work in the Australian Alps hasn't made it into my thesis, this is a large body of research that will be an important part of my future works (Chapter 9).

None of the fieldwork would have been possible without the support of Blue Mountains and Southern Ranges branches of National Parks and Wildlife Service (NPWS), WaterNSW and Parks Victoria, all of whom have been exceptional to work with. Thanks in particular to NPWS Chris Banffy and Rob Gibbs for being so generous with their time and knowledge, providing field guidance, and expanding my knowledge of the regions and the challenges in wild horse management. Thanks also for valuing my research in the context of wild horse management. This led me to be appointed by the Minister for the Environment as the veterinarian and animal welfare



expert, and Deputy Chair, of the NSW Governments Scientific Advisory Panel for wild horse management in Kosciuszko National Park, for the last 2 years. Whilst this substantially slowed down my thesis writing, having the opportunity to have directly advise on wild horse management policy has been hugely rewarding and the ultimate culmination of my PhD research (Appendix 7). Huge thanks to the rest of the panel, and also NPWS Mick Pettit and Donna Sampey for being such a pleasure to work with, receptive to my ideas, and continuing to teach me so much. In this role I have also enjoyed and valued working alongside members of the Community Advisory Panel, and I thank them also for teaching me particularly about many of the historical aspects of wild horses in the Australian Alps, and sharing their valuable local knowledge.



(a)



(b)

**Figure 4. (a)** Cat Butler, Kedumba River, Blue Mountains; **(b)** Talsy Watts (right) and myself, Coleman Plain, Kosciuszko National Park.

To all my field volunteers, many of whom were colleagues from my veterinary work, for making my field work the most memorable and enjoyable aspect of my PhD. My love for the Australian bush certainly flourished, and the time spent in the bush became much more than just researching wild horses. Working dawn until dusk and then crashing out in a swag under the stars became part of normal life. Kedumba valley and The Australian Alps were my 2<sup>nd</sup> home for a couple of years, and they will always hold a special place in my heart full of fond memories. Particular thanks to Vibeke Russell for literally being my right hand for over a year of field trips in Kedumba Valley (Figure 5). I will forever be so grateful to Vibeke for sharing and whole heartedly participating in this part of my journey. Some of the first wild horses we ever observed together are now at our sanctuary, and a daily physical reminder of what we achieved together, but that is another long story! (Chapter 9).



(a)



(b)

**Figure 5.** (a) Co-supervisor Rosalie Chapple (left) and myself overlooking Kedumba Valley, Blue Mountains; (b) Vibeke Russell (right) and myself on fieldwork.

Data analysis and statistics would not have been possible without the help of John Morton. I cannot express the extent of my gratitude to John, who provided data and statistical analysis, but also so much more than that. John showed genuine interest in my work and always went above and beyond, being probably the only other person in the world to become almost as excited as me about my data! John became such a valuable sounding board and his kindness, patience and enthusiasm in each zoom meeting lifted my spirits and motivated me during periods when my morale was often low.

Most importantly, heartfelt thanks have to go to all my animals, who enthuse and inspire me daily, continue to teach me so much, and are my reason for living when life gets tough. The saying in our household is ‘welfare starts at home’, meaning that the welfare of the animals under our care at home and at our sanctuary always take priority. By necessity this meant that my PhD had to often take a backseat whilst I treated sick animals, grieved over animals that we had to say goodbye to, and when I had to intensively care for them during the trifecta of natural disasters that spanned over 3 years of my PhD candidature with drought, bushfires, and floods and the long recovery period that followed (Figure 6), not to mention the COVID-19 pandemic that impacted us in the final year of my candidature.

A memorable and perhaps surreal moment during the early stages of writing up, was responding to reviewers comments on my Chapter 2 paper as bushfires were ripping through our property for the 4<sup>th</sup> consecutive day. Having worked tirelessly to keep all

our animals safe and staying up all night checking for embers around the house, I had barely slept for a week by that stage. I thank the *Animals* Editorial assistant for their understanding during this time when I had to pack up my laptop ready to leave the house and tell them 'I'm not sure when I will get back to this!' It was often hard to find the time and focus for my thesis during the long and ongoing recovery period that followed, but different aspects of animal welfare were always at the forefront of my mind. I captured some of the animal welfare issues that I grappled with during the bushfires in an article for *The Veterinarian* (Appendix 8). I thank the many friends and colleagues that played a role in lifting my spirits and giving me the strength to continue writing my thesis during these turbulent times when it often felt meaningless.



**Figure 6. (a)** Some of the brumbies at our sanctuary that I cared for during a trifecta of natural disasters spanning 3 years of my candidature; **(b)** The devastation around us following the bushfires. The red cross marks where our house is.

Finally, thanks to my parents, who as a result of my field work, followed by our trifecta of natural disasters, and then the COVID-19 pandemic, I have been unable to see since they visited here right at the beginning of my candidature in 2015. Despite having been on the other side of the world for the last 11 years, and a fairly absent workaholic veterinarian for the preceding 10 years, the philosophies they instilled in me as a child to be humble, kind, generous and work hard, have always continued to stand me in good stead to succeed in a range of endeavours. Their encouragement to always follow my heart led me back to my passion for horses, that I had since a young child. And the motto of 'having a job that you love means you never work a day in

your life', has enabled me to continue to disguise long hours of working as just having fun.

The journey of my PhD candidature through many adverse times, certainly has been a labour of love, but has proved to myself that with determination and resilience, anything can be achieved.

# List of Chapters and Statement of Author Contribution

This thesis has nine chapters. It is a compilation of 3 manuscripts published in peer-reviewed journals (Chapters 2, 4 and 5), and 6 chapters that are not yet published, but will also be submitted for publication. Referencing styles were standardised throughout the thesis in accordance with those of the journal *Animals*.

## Chapter 1

Introduction: The wild horse controversy and the importance of incorporating animal welfare science in decision making

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<b>Daniel Ramp</b> Production Note: Signature removed prior to publication.	Conceptualisation 20% Review and editing of final draft 10%

## Chapter 2 – Published Paper

Harvey, A.M.; Beausoleil, N.J.; Ramp, D.; Mellor, D.J. A Ten-Stage Protocol for Assessing the Welfare of Individual Non-Captive Wild Animals: Free-Roaming Horses (*Equus Ferus Caballus*) as an Example. *Animals* **2020**, *10*, 148.

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### Chapter 3

A review of the species-specific information required to enable assessment of wild horse welfare

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## Chapter 5 – Published Paper

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## Chapter 6

Scientific validation of welfare indicators for using the Five Domains Model to grade the welfare status of individual free-roaming wild horses

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## Chapter 7

Dynamic changes in wild horse social organisation and habitat use revealed with remote camera-trap monitoring

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## Chapter 8

The cascading influence of resource availability on the welfare status of wild horses, and association with demography, social organisation and habitat use

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## Chapter 9

### Conclusions and future directions

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## Thesis Abstract

Knowledge of the welfare of wild animals contributes vital information to ethical, legal, and political debates about our interaction with wild animals and their habitats. Despite this, there has been little insight into how to assess their welfare and factors affecting it. Wild horse management exemplifies a highly controversial wildlife issue, where to date, welfare has not been assessed or incorporated into management decision making.

My thesis aims to (i) develop methodologies for scientifically assessing the welfare of free-roaming wild animal species, (ii) apply these methods to assess the welfare of free-roaming wild horses across a range of habitats, and (iii) explore the spatial and temporal changes in welfare, and the relationship between welfare status, population dynamics, social organisation, habitat use, and resource availability.

Chapter 1 introduces the controversies in wild horse management and why welfare assessment is important. In Chapter 2 I develop a novel conceptual framework, the 'Ten-Stage Protocol', for advancing the practical capacity to assess welfare in free-roaming wild animal species. Chapters 3 to 8 then apply this framework to wild horses, demonstrating how this protocol can be practically applied to obtain meaningful, systematic, structured, transparent, and scientifically objective assessments of welfare. Whilst my thesis is based on free-roaming wild horses, it has been developed specifically to form the basis of application of these processes to other species.

In Chapter 3, I review the current state of wild horse knowledge, presented in a holistic and multidisciplinary framework. I demonstrate (Chapter 4) the type of research required to address knowledge gaps, using the example of wild horse parasitology.

Chapter 5 investigates the use of remote cameras for identifying individual wild horses across different habitats, and for acquiring data on an extensive range of welfare indicators. Chapter 6 comprises scientific validation of these welfare indicators and refinement of a Five Domains welfare grading scheme. I then (Chapter 7) evaluate population dynamics, and temporal and spatial changes in social organisation and habitat use of a wild horse population over a 15-month period, using the remote camera methodology established in Chapter 5. I further evaluate welfare status demonstrating the cascading effects of resource availability, and how this correlates with population dynamics, social organisation, and habitat use (Chapter 8).

Finally, Chapter 9 summarises how this research has advanced knowledge, assisted with management decision-making to improve the welfare of wild horse populations, and contributed to conflict resolution in wild horse management.

**Thesis outline summarizing chapter titles and contents**

<b>Chapter</b>	<b>Chapter title</b>	<b>Brief description</b>
<b>1</b>	<b>Introduction: The wild horse controversy &amp; the importance of incorporating animal welfare science in decision making.</b>	<b>Summary of the history of wild horses, their cultural significance, environmental impacts and controversies in wild horse management. Introduces the importance of animal welfare science in wild animal controversies.</b>
2 Published	A Ten-Stage Protocol for assessing the welfare of individual non-captive wild animals: free-roaming horses as an example.	Presentation of a novel conceptual framework that I designed in order to guide a systematic and scientific approach to assessing the welfare of free-roaming wild animals, using the Five Domains Model. Summarizes the principles of interpreting indicators of biological function and behaviour in terms of the mental experiences that those indicators reflect (Stage 1 of my Protocol), and how the Five Domains Model is used for assessing welfare (Stage 2 of my Protocol).
3	Literature review: A review of the species-specific information required to enable assessment of wild horse welfare.	The current status of wild horse knowledge is summarized in a novel holistic and multidisciplinary framework drawing together the relevant literature on horses across each of the four physical/functional domains of the Five Domains Model. It addresses Stage 3 of my Ten-Stage Protocol.
4 Published	Addressing the knowledge gap of gastrointestinal parasitology in free-roaming wild horses in south-east Australia.	An example of the type of detailed original research required for addressing any knowledge gaps identified in Stage 3. This chapter describes a detailed parasitological investigation of 293 faecal samples collected from 6 wild horse populations. It describes results of faecal egg counts, larval cultures and molecular diagnostics.
5 Published	Use of remote camera traps to evaluate animal-based welfare indicators in individual free-roaming wild horses.	A large body of original research investigating for the first time, both the use of remote cameras for identifying individual horses across a range of habitats, and for acquiring data on an extensive range of animal-based welfare indicators. It addresses Stages 4-6 of my Ten-Stage Protocol.
6	Scientific validation of welfare indicators for using the Five Domains Model to grade the welfare status of individual free-roaming wild horses.	Addressing Stage 7 of my Ten-Stage Protocol, this chapter evaluates the scientific evidence linking the described objective measurable/observable welfare indicators to physical/functional impacts in Domains 1-4, and the relationship between those impacts and the mental experiences that are inferred in Domain 5. This concludes with the formulation of a Five Domains Model wild horse specific welfare grading scheme.
7	Dynamic changes in wild horse social organisation and habitat use revealed with remote camera trap monitoring.	With the aim of evaluating traditional ecological metrics alongside welfare status, this chapter describes original research using the remote camera trapping methodology described in chapter 5, to evaluate population dynamics, and temporal and spatial changes in social organization and habitat use of a wild horse population over a 15 month period.
8	The cascading influence of resource availability on the welfare status of wild horses, and association with population demographics, social organization and habitat use.	This original research applied the methodology from all preceding chapters to assess welfare status and changes in welfare status in individual wild horses over a 15 month period, addressing stages 8 -10 of my Ten-Stage Protocol. It further evaluates drivers of change in welfare status and correlations between welfare status, and the population dynamics, social organization and habitat use described in chapter 7.
9	Conclusions, application, and future directions.	Summarizes overall conclusions, and contributions to the fields of wild animal welfare, wild horse ecology and welfare, wild horse management, and general horse welfare. Highlights ongoing work, some of which I have already partially completed that was not included in the main body of the thesis.