NSW GOVERNMENT Office of Environment & Heritage

Final report of the Independent Technical Reference Group

Supplementary to the Kosciuszko National Park Wild Horse Management Plan

This report was prepared for OEH by the Independent Technical Reference Group (ITRG):

Dr Mark Lonsdale, Monash University and Charles Darwin University (Chair)
Dr Bidda Jones, RSPCA Australia (Deputy Chair)
Dr Sara Beavis, Australian National University
Professor Elissa Cameron, University of Tasmania
Professor Emeritus Geoffrey Hope, Australian National University
Professor Emeritus Reuben Rose, University of Sydney
Dr Glen Saunders, NSW Department of Primary Industries
Professor Alan Welsh, Australian National University.

The ITRG may be contacted via joanne.knowles@environment.nsw.gov.au

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Office of Environment and Heritage
59 Goulburn Street, Sydney NSW 2000
PO Box A290, Sydney South NSW 1232
Phone: +61 2 9995 5000 (switchboard)
Phone: 131 555 (environment information and publications requests)
Phone: 1300 361 967 (national parks, general environmental enquiries, and publications requests)
Fax: +61 2 9995 5999
TTY users: phone 133 677, then ask for 131 555
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Key findings

I. The Independent Technical Reference Group (ITRG) has not been able to reach a conclusion on trends over time in horse numbers or densities in Kosciuszko National Park (KNP) because of problems of comparability between successive horse surveys (see Section 2, *Are horse numbers on the increase?*).

II. The ITRG considers that a figure of about 6000 horses in KNP in 2014, from the draft aerial survey report (Cairns 2015), is a reasonable working estimate to guide future management of horse impacts (see Section 2.4, *How many horses are in the park now?*).

III. The ITRG finds, based on published scientific criteria (Bomford & O'Brien 1995; Simberloff 2003), that eradication of wild horses from KNP is not achievable, although their complete exclusion from certain parts of the park is possible (see Section 5.2, *Is eradication of wild horses from KNP feasible?*).

IV. The ITRG concludes that the evidence of environmental harm is sufficient that wild horse populations must be managed in KNP (see Section 3.2.5, *Conclusions – the environmental impact of horses*).

V. A significant majority of stakeholder organisations who provided submissions and presentations to the ITRG, including some of those who are essentially pro-horse, provided submissions supporting the contention that some management of wild horses was necessary in KNP (see Section 5.4, *Stakeholder submissions to the ITRG*).

VI. The ITRG has carried out a thorough consideration of the humaneness and utility of various control methods for horses in KNP (see Section 4, *If horses have to be removed, what methods are currently or potentially available?*). Of the live capture methods assessed, we found that passive trapping and mustering in small groups had the lowest relative impact on animal welfare, when considered up to the point of removal from the park.

VII. Of the in situ lethal control methods assessed, aerial shooting under a 'best practice scenario' had the lowest overall animal welfare impact. Where these conditions are not achievable, ground shooting, or passive trapping/mustering followed by on-site humane killing, were the next best options.

VIII. Fertility control is only a viable option where horse densities are already low and the objective is to gradually reduce or maintain the population at a low density. Its broad-scale effectiveness in the context of KNP (or in any other large wild population) is yet to be determined (see Section 5.7.2, *Control methods assessed in a management context*).

IX. The ITRG considers that dividing the park into specific zones to facilitate management of wild horses will allow coexistence of diverse values in KNP, and provides scientific criteria and options for how such zones may be delineated and applied (see Section 5, *What are the options for management of wild horses in KNP?*). In these zones, different combinations of control methods would apply, using an integrated approach to increase effectiveness. The outcomes of management would ideally be monitored primarily through the effects on agreed impact measures or thresholds of concern, rather than just on horse numbers or densities.

X. The ITRG has identified a series of recommendations below, and a set of research projects/priorities to fill critical knowledge gaps (see Section 6, *What are the priorities for research to inform management of wild horses in KNP?*), to assist the Office of Environment and Heritage (OEH) in managing wild horses in KNP.

Recommendations

ITRG recognises that it is making its recommendations based on the present situation and that both the dynamics of wildlife populations and their impacts can change over time. For this reason, an adaptive management approach must be applied (Allan 2007) – a process where the impact of management decisions is carefully monitored and the results fed back into future decision-making. A structured approach to adaptive management has been adopted previously by OEH (OEH 2015), and this could be drawn on to inform future management approaches. Furthermore, ITRG makes its recommendations on the understanding that the implementation of a long-term management plan for wild horses in KNP will require a long-term budgetary commitment by the Government.

The ITRG recommends that:

1. the Office of Environment and Heritage (OEH) note the conclusion of the ITRG that horses do have negative impacts on the environmental values of KNP and therefore need to be managed to reduce those impacts
2. OEH consider implementing management zones within the three broad regions of the park, according to the scientific criteria developed by the ITRG. Within these zones, horses may be excluded or managed to achieve planned acceptable ecological impact levels. 'Acceptable ecological impact' would be determined through scientific consideration, and would include zero impact in areas of KNP deemed particularly sensitive
3. outreach material to communicate the background and intent of the Wild Horse Management Plan to the wider community be used to publicise the availability of wild horses for domestication and rehoming, to build demand from suitably qualified organisations, as this lack of demand is a bottleneck in the implementation of non-lethal control measures
4. OEH reconsider its approach to and objectives for horse survey work, emphasising surveys of environmental damage (instead of just horse numbers), and robust measurement of its trends over time, given that reducing such damage is the ultimate aim of the management plan. OEH could consider forming an advisory group of limited duration to assist in this survey strategy re-design
5. OEH consider the inclusion of a range of lethal control methods, including aerial shooting, in future management plans, with consideration given to implementing an auditing or inspection process to measure compliance with best practice requirements for humaneness
6. OEH consider establishing a research hub to help focus horse research efforts and avoid any duplication or unnecessary research, because the ITRG concludes that there are significant knowledge gaps in our understanding of horses in KNP. OEH could start the process with a workshop bringing together key research players and stakeholders
7. OEH consider incorporating scientific advice in any consultative group established to support the implementation of the management plan
8. OEH consider developing contingency plans for horse control in response to fire, drought, disease, and climate change, in order that it conform to the *NSW Biosecurity Strategy 2013–2021* requirement that management plans be able to adapt to changing environmental circumstances. In doing so, the *NSW Biosecurity Strategy 2013–2021* (NSW Government 2013) and the Animal Health Australia AUSVETPLAN *Wild Animal Response Strategy* (Animal Health Australia 2011) may be used for guidance.

1. Introduction

1.1 Wild horse management in Kosciuszko National Park

Horses first arrived in Australia with the First Fleet (Csurhes et al. 2009), having been picked up at the Cape of Good Hope (Crossley 2006), and were first recorded as escaping into the wild or being abandoned in 1804 (Csurhes et al. 2009). Wild horses are now widespread in Australia, in parts of the Northern Territory, western and northern Queensland, the arid zone of South Australia, and the northern rangelands of Western Australia, together with isolated populations in NSW and Victoria and periodic occurrences in the ACT (Dawson et al. 2006, p. 7). Horses were introduced to the region that is now the Australian Alpine National Parks (including Kosciuszko) with European settlement (Dawson & Hone 2012) and were estimated to number about 7000 across 3000 km^2 by 2009 (Dawson 2009).

Horses played a vital role in the expansion of Australia's agriculture and transport networks, and it was only in 1948 that the number of motor vehicles in Australia first exceeded that of horses (Crossley 2006). Horses were also important in Australia's military history (e.g. the Australian Light Horse), as well as being exported in great numbers (the so-called 'Walers') to the British Army in India in the 19th century. Horses are a central part of Australian national culture, being on our ten-dollar note, for example, and having featured in the Sydney Olympics opening ceremony. Horses evoke a strong emotional response, and any horse management plan must be socially acceptable. For example, a study of attitudes to wild horse management in Victoria (Nimmo & Miller 2007) found that the community generally rejected lethal control of horses. The 21% who regarded horses as a pest, however, were significantly more likely to approve of the culling of wild horses from conservation areas (Nimmo & Miller 2007). In Kosciuszko, for some visitors, the sighting of introduced animals such as wild horses detracted from their visit, while for others, such encounters may have added to the richness of their experiences in the park (DECC 2008; but see the Straight Talk 2015 report for an up to date appraisal of community attitudes).

On the other hand, there are serious concerns about the impact of wild horses on alpine environments. Kosciuszko National Park (henceforth KNP) is the largest national park in NSW and one of the largest conservation reserves in Australia. The park is now a UNESCO Biosphere Reserve. It contains continental Australia's highest mountains and a great variety of outstanding natural features and biodiversity. The NSW National Parks and Wildlife Service (NPWS) has a legal responsibility to protect the park's habitats, flora and fauna, and geological features. Control of horses in the park began in the early 1970s with a licensed horse roping/brumby running program, but concerns over the inhumaneness of this practice resulted in its being banned. By the late 1990s concern grew about the environmental impacts from a growing horse population, and in 2000, the Snowy Mountains Region of NPWS began to prepare a horse management plan to protect the alpine area of the park. The plan was released and implemented in 2003.

In 2006 a plan of management for Kosciuszko National Park was formally adopted (DEC 2006). One of its objectives was to reduce the distribution and abundance of introduced animal species found in the park. The plan of management called for the exclusion of horses from key areas and for a KNP Horse Management Plan to be prepared for the whole of the park. This plan was released in 2008 (DECC 2008).

1.2 Role of the Independent Technical Reference Group

Following its release, the NSW Minister for the Environment asked NPWS to conduct a review of the KNP Horse Management Plan to look at wild horse impacts on the reserve's environment and consider all best practice control methods currently available. An Independent Technical Reference Group (ITRG) was subsequently formed to provide independent and rigorous scientific and technical advice to OEH and NPWS on the management of wild horses within KNP.

The ITRG is addressing its terms of reference, as provided in Appendix A. It has also formulated a code of conduct, as required by the NSW Government for all its advisory committees.

The members of the ITRG and their areas of expertise are as follows:

- Chair, Dr Mark Lonsdale, Monash University and Charles Darwin University – invasive species
- Deputy Chair, Dr Bidda Jones, Chief Scientist, RSPCA Australia – animal welfare and behaviour
- Dr Sara Beavis, Australian National University – soil erosion and soil processes
- Professor Elissa Cameron, Professor, Wildlife Ecology, University of Tasmania – horse / vertebrate ecology
- Professor Emeritus Geoffrey Hope, Australian National University – biology and ecology of the flora and fauna of the Australian Alps
- Professor Reuben Rose, Emeritus Professor of Veterinary Science, University of Sydney – animal welfare and equine veterinary science
- Dr Glen Saunders, Visiting Scientist, NSW Department of Primary Industries – invasive animal ecology and management
- Professor Alan Welsh, Australian National University – statistics.

It should be noted that the focus of the ITRG is on the environmental and animal welfare implications of wild horses and their management in KNP, as reflected by its make-up. The socio-cultural aspects of wild horse management are dealt with by the community engagement process and the heritage assessment, and are out of scope for the ITRG to actively explore. Nevertheless, the ITRG, in formulating its recommendations, needed to be aware of community attitudes, and accordingly, the ITRG was briefed on their findings by the consultants conducting the community engagement process (see Straight Talk 2015), and had access to the heritage assessment report (Context 2015). In addition, the ITRG invited stakeholders to submit any relevant research, information or evidence for its consideration (see Appendix B).

1.3 Methodology of this report

The key task for the ITRG was to address its terms of reference through the following questions, which it did by drawing on its collective scientific insights, and reviewing the relevant scientific literature, as well as the various reports on wild horses in KNP:

1. Are horse numbers on the increase?
2. Do horses have an impact on park values?
3. If horses have to be removed, what methods are currently or potentially available?
4. What is the range of management options for horses in KNP?
5. What are the priorities for research to inform management of wild horses in KNP?

These questions were first formulated by the ITRG at its inaugural meeting, and refined and augmented in consultation with OEH to ensure they were relevant to the needs of the management plan. Collectively, the responses to all these questions, based on thorough analysis by the ITRG, are contained in this final report, and constitute a comprehensive response to the terms of reference (Appendix A).

To address its terms of reference, the ITRG carried out much of its work out of session using email correspondence between members. However, the following meetings, teleconferences, workshops and briefing sessions, have been held.

Table 1: Meetings held by the ITRG to October 2015

Meeting	Date	Purpose
Inaugural meeting of ITRG	9 December 2014	Briefing of ITRG by OEH Planning of ITRG work
ITRG teleconference	27 January 2015	Planning of ITRG Planning of field trip to KNP
Field trip to KNP	5–7 February 2015	Familiarisation of ITRG with KNP landscapes, impact of wild horses in field, current management approaches
Briefing on community engagement strategy	27 February 2015	Outline of approaches used to consult community and stakeholders, and findings of work so far
ITRG meeting	27 February 2015	Review work plan and progress to date
Stakeholder consultation	26 March 2015	ITRG to hear presentations from stakeholders
Humaneness assessment panel workshop	24 April 2015	Rigorously assess humaneness of different control methods
ITRG subcommittee on control methods	25 June 2015	Review application of control methods in KNP
ITRG meeting	17 September 2015	ITRG drafting session for final report (Dr Lonsdale via teleconference)
ITRG meeting	29 October 2015	Review work plan and progress to date
ITRG writing workshop	29–30 October 2015	To draft the final report

2. Are horse numbers on the increase?

The ITRG has examined a range of material on horse numbers, including past survey data for the Australian Alps. There are indications from the various sources we surveyed that populations are increasing in some areas of KNP. However, the ITRG cannot, at this stage, draw rigorous scientific conclusions about how numbers and population trends are changing over time, or how they may differ in different parts of the park. This is because of differences in approach between the various surveys. Concerning present (2014) numbers in KNP, however, the most recent aerial survey report, currently under revision, indicates a preliminary figure in the order of 6000 horses, which the ITRG concludes is a reasonable working estimate to guide future management.

2.1 Assessing trends in horse numbers

Whether horse numbers are on the increase is an important question as it helps to establish whether past management efforts have been sufficient. The best available data on horse numbers in the Australian Alps National Parks are provided by large-scale aerial surveys of the horse populations carried out in 2001, 2003, 2009 and 2014. The available data on the density of horses in the Australian Alps National Parks are given in Table 2. These data include material from the latest (2014) aerial survey, available to the ITRG as a draft (Cairns 2015) that is still under active revision at the time of finalisation of our report. An important issue for the ITRG, however, is that there were changes between years in the areas surveyed, the survey technique and the analysis used. In particular, changes in the survey area, design and methodology were made for the 2014 survey in response to criticism by stakeholder groups of the previous surveys, to improve the precision and accuracy of the survey, and to accommodate changes in Work Health and Safety requirements for the configuration of aircraft during low level flight operations. The principal aim of the 2014 survey was to 'produce reasonably accurate and precise estimates of the numbers of feral horses in the survey area', while 'considerations of the rate of change of the population were considered to be of secondary importance relative to an accurate and precise survey' (Cairns 2015). Certainly, the changed survey methods in 2014 achieved a reduced coefficient of variation in density estimation (Table 2); on the other hand, the differences in surveys between years are confounded with possible changes in the horse populations.

Table 2: Areas, estimated densities of horses and coefficients of variation from four aerial surveys of horse populations in the Australian Alps National Parks and adjacent state forests

The first three rows are extracted from Table 2 in Dawson (2009); the last row is from Table 5 in Cairns (2015).

Year	Area surveyed (km^2)	Density (horses/km^2)	CV (%)
2001	2,789	1.86	31.6
2003	2,717	0.87	33.8
2009	2,860	2.69	25.3
2014	5,429	1.70	11.3

The important differences between the various surveys relate to the areas surveyed and the way in which clusters of horses are converted to individual horses. It is natural for data collection for a herding animal to focus on clusters of horses rather than individual horses, but it does introduce complications into the analysis. The ITRG cannot resolve these complications, nor can it extract the population growth trends that would allow us to answer the headline question.

In conclusion, differences in survey area, design and analysis between the various surveys make it impossible for the ITRG to infer trends over time in the overall density of horses.

2.2 How do densities and rates of increase vary across the park?

It is quite possible that the density of horses is changing in different ways in different parts of the Australian Alps National Parks. The differences between the surveys noted above, however, also complicate regional comparisons, and attempting to do so would require the ITRG to ignore substantive methodological issues.

For example, Dawson (2009, p. 9) presented estimated numbers of horses for the Victoria and NSW regions but these were obtained by simply multiplying the density and standard error in her Table 1 by the areas of these regions (1282 and 1578 km^2 respectively). Thus

these results assume that the density is constant across the whole area and cannot be used to explore how densities varied across the park in 2009.

Cairns (2015, Table 8) reanalysed the 2009 survey data and reported estimated densities in 2009 for the North Kosciuszko and Byadbo–Victoria survey blocks of 1.25 and 0.57 horses per km^2 respectively. Comparing these 2009 estimates to his 2014 estimates (modified to include the unsurveyed steep areas of the survey blocks) of 2.74 and 0.77 horses per km^2, (Cairns 2015, Table 8), gave annual rates of increase of 1.17 (i.e. 17%) and 1.06 (i.e. 6%). However, the low 2009 densities calculated for North Kosciuszko and Byadbo–Victoria are not compatible with the much higher *overall* density in the 2009 survey report (2.69 horses per km^2; Dawson 2009). Either the estimates for the 2009 densities in North Kosciuszko and Byadbo–Victoria (Cairns 2015) are too low or Dawson's (2009) estimate of the overall density is too high. Further analysis of the relationship between the 2009 and 2014 data needs to be done, but the ITRG cannot, as yet, itself draw conclusions on how densities and rates of change vary across the park.

There are two other sources of data that may provide some insight into changes in specific regions within the Australian Alps National Parks. These are the mark–recapture helicopter surveys carried out at Big Boggy, and horse count flights over North Kosciuszko.

The surveys of Big Boggy (approximately 35 km^2) carried out in 2006, 2007, 2008, 2010, 2011 and 2015 are much more limited in extent than the large-scale aerial surveys and use a different survey protocol and different statistical methodology. There are acknowledged difficulties in maintaining consistent timing (before the first snow) and survey effort (distance flown and the route flown) across surveys that hinder the interpretation of the results. The estimates obtained in the surveys are given in Table 3. Although some of the unreported numbers can be inferred, we have included only published numbers.

Table 3: Approximate area, estimated number of horses, estimated density of horses and coefficient of variation (CV) from six aerial surveys of horse populations in the Big Boggy region of the Australian Alps National Parks

The first row is from Dawson (2005); the next two rows are extracted from the 2006 and 2007 reports; the fifth row from the 2010 report; the last two rows from the 2015 report. We have not been able to access the reports for 2008 or 2011.

Year	Approximate area (km^2)	Number of horses	Density (horses/km^2)	CV (%)
2005			2.01	
2006	29	81		10.64
2007	33 & 35.3	141	4.15	8.93
2008				
2010		115	3.50	7.53
2011		98		
2015	35	195	5.57	7.10

Taking these surveys and results at face value, the estimates may suggest that the number of horses initially increased, stabilised or decreased slightly for a while and then increased again from 2011. Note that horses have been removed from Big Boggy each year over the period, although the number removed has decreased in recent years: in the year before the 2007 survey, 41 horses were removed; before the 2008 survey, 65 horses were removed; in the two years before the 2010 survey, 25 and 31 horses were removed; before the 2011 survey, 25 horses were removed; and in the four years before the 2015 survey, 13, 10, 7 and 11 horses were removed.

The horse count flights over Northern Kosciuszko involve a meandering flight over the area and an attempt to count all the horses present. There are potential problems with differences in survey effort, non-detection and double counting but, given that there are also problems with the more formal surveys, these informal figures may still give a rough indication of trends (Table 4).

Table 4: Observed numbers of horses in the Northern KNP region of the Australian Alps National Parks according to data taken from the flight maps

Year	Number of horses
1998	75
2008	558
2010	1,460
2011	1,262
2012	1,312
2013	1,646
2014	1,637

Taking these counts at face value suggests an increase in the number of horses through time, with extremely high numbers since 2010 (Table 4). These raw counts are, however, not directly comparable to the estimates obtained from the aerial surveys.

In general, while there are indications from the various sources above that populations are increasing, the ITRG cannot at this stage draw rigorous scientific conclusions about how densities and rates of change vary across the park.

2.3 What impact would different levels of removal have on horse numbers?

The impact of removals is entirely dependent on how fast the population is changing. Since at this stage, however, we do not have reliable estimates of population change, the best we can do is assume that the population growth falls somewhere near the average for wild horses globally. Data from other wild horse populations, summarised in Table 5, do suggest that the population is likely to increase (unless there are substantial natural disasters such as fire, or substantial predation rates by, for example, wild dogs).

Horse populations where demography has been well studied tend to show a range of population growth rates (per horse per annum) from $r = 0.043$ to $r = 0.188$ (Table 5). Higher rates of population growth have been recorded when new populations are formed. For example, for the six years following population establishment in the Camargue, the population grew at a rate of $r = 0.277$, as the population grew from 14 to 56 horses. Growth rates subsequently declined to $r = 0.150$ (Grange et al. 2009). The only unmanaged feral horse population reported to be maintaining a population that is not increasing is in Montgomery Pass Wild Horse Territory, California, where horse numbers are controlled by mountain lion predation, with 45% of all foals born killed by mountain lions (Table 5; Turner & Morrison 2001).

Table 5: Demographic parameters of wild horse populations

	Great Basin (Berger 1986)	Camargue (Grange et al. 2009) Initial/later	Pryor Mountain (Garrott & Taylor 1990)	Kaimanawa Mountains (Cameron et al. 2001; Linklater et al. 2004)	Cumberland Island (Goodloe et al. 2000)	Montgomery Pass (Turner & Morrison 2001)
Population per capita annual growth rate (*r*)[a]	0.188	0.277/0.150	0.113	0.092	0.043	0
Foaling rate	0.9	0.92/0.93	0.55	0.61	0.66	~0.6
Foal survival	0.92	0.95/0.62	0.94	0.83	0.6	0.32
Age at first reproduction (years)	3	2/2	3	3 (occasionally 2)	3	3
Adult survival	0.95	0.99/0.90	0.97	0.95	0.92	0.92

[a] Note also data for Central Australia indicating $r = 0.29$ per horse per annum, in the short term, in response to heavy rain and plentiful resources (Kampmann et al. 2013).

Disease and predation, including from wild dogs, are unlikely to be having a major impact on the KNP population, and even taking a low estimated population growth rate ($r = 0.10$), the wild horse population in KNP would grow by over 50% in five years, and would double in around 7–8 years, if unchecked. Although this should not be treated as a firm prediction, it underscores the risk of leaving horse populations unmanaged in a park that is critically important for Australia's national conservation effort. An increased population not only intensifies any environmental harm, it also compounds the management challenge, including animal welfare issues, of returning the numbers to acceptable levels. Thus, taking a precautionary approach (as advocated by the NSW *Protection of the Environment Administration Act 1991*), the ITRG concludes that management is required to hold the population density at or below the current level.

Were we to get good estimates for population growth rate, we would be able to predict the impact of removing a certain number of horses on the population size. However, it should be noted that if the population size is substantially reduced, horse breeding is likely to increase. This is influenced by three factors in particular: a) age at first breeding in mares (this decreases as mares can fall pregnant as yearlings under good conditions at low density); b) frequency of foaling (this normally averages around a foal every second year, but could average a foal a year under good conditions), and c) foal survival, particularly if survival is mostly influenced by food availability (Grange et al. 2009). Other factors that may influence foal survival can be independent or negatively related to density, such as predation (wild dogs in this area, probably only of very young foals; Turner & Morrison 2001), and infanticide (usually higher at higher densities as foals are more likely to encounter stallions that are not their father; Gray et al. 2012). Of course, all these factors will also change yearly with environmental factors. Contraception, if developed, could be a useful alternative to removals as while it would not reduce population numbers immediately, it could hold them at a lower rate of increase or even cause a decline. However, complications could also arise from applying contraception in wild populations (see Section 5.7.2, *Control methods assessed in a management context*).

In conclusion, we might make assumptions that allow us to predict the immediate impact of removals on numbers, but the lack of any suitable data for horses in the Australian Alps

National Parks makes it difficult to choose between these predictions. The lack of local demographic data makes predicting the longer-term impacts of removals even more difficult. The collection of such data, and the building of a population model for horses would be a useful area for future research (see Section 6, *What are the priorities for research to inform management of wild horses in KNP?*), as it would help to inform management decision-making.

2.4 How many horses are in the park now?

The draft 2014 aerial survey report (Cairns 2015), gives overall population estimates for the Australian Alps region of 9455 horses (95% confidence interval (CI): 7484 – 11,595). This figure was based on extrapolating from counts of groups of horses, but an analysis based on individual animals gave a similar answer: 9520 horses (95% CI: 7529 – 11,814; Cairns 2015). These data are for the Alps as a whole. To derive a count for horses in KNP, the survey report used horse density estimates, analysed within a geographic information system to separate the estimates relevant to KNP (Cairns 2015). This indicated a figure for KNP of 6150 horses (Cairns 2015; CI not provided). The ITRG concludes that a figure in the order of 6000 horses in KNP in 2014 is a reasonable working estimate to guide future management.

3. Do horses have an impact on park values?

The ITRG concludes that the balance of evidence indicates that wild horses are having a significant negative environmental impact on Australian alpine and sub-alpine ecosystems in Kosciuszko National Park. This is particularly true for alpine bogs, waterways and drainage lines. Any supposed positive environmental impacts are not supported by scientific evidence. On the other hand, the ITRG recognises the cultural significance of wild horses in the region, as detailed in the Context (2015) report.

3.1 What impacts – positive or negative – are occurring?

3.1.1 Scope

The ITRG is required to focus on environmental impacts in its deliberations, and its expertise reflects this. We will refer to the literature on the cultural significance of horses below, however these aspects are treated in detail in the heritage report (Context 2015).

3.1.2 Environmental impacts

There are serious concerns about the impact of wild horses on the environment of KNP. The park is the largest national park in NSW and one of the largest conservation reserves in Australia, preserving the only true alpine zone in mainland Australia and extensive sub-alpine (below tree line) areas. It has the most extensive peatlands in the Alps. The park is now a UNESCO Biosphere Reserve.

Ungulates are important ecosystem modifiers, influencing a range of ecosystem factors in both positive and negative ways, beyond simply eating the grass (Hobbs 1996; Augustine & McNaughton 1998). Non-native grazers that are unmanaged are known to have substantial impacts on ecosystem integrity (Fleischner 1994). Therefore, it is probable that horses alter the ecosystem in the Alps. Earlier (1880–1940) uncontrolled grazing at Kosciuszko led to extensive erosion and removal of palatable species (Wimbush & Costin 1979, 1983; Good 1992; Green et al. 2005). In particular, peatlands were eroded and dried with large areas being reduced to mineral soils (Hope et al. 2012). Associated with the grazing regime was

widespread firing which decimated the sub-alpine woodlands; recovery from this damage has involved revegetation and in a few cases repair to peatlands to accelerate succession to sphagnum moss bog (Hope et al. 2012).

The documented negative and positive environmental impacts of horses in various habitats across the globe are summarised in Table 6. Specific effects of herbivory depend on interactions between the ungulate and the environment, particularly the plant community, landscape, soil and climate (Hobbs 1996). While studies on herbivory are widespread, there is less information specifically on the effects of horses. This is because controlled experimental studies are rare, and most rely on a correlational approach and are often complicated by the presence of other herbivores (Beever & Brussard 2000). Exclosure plots that exclude all grazing herbivores are likely to exaggerate the impacts of horses (Linklater et al. 2002). Some studies fail to find an effect, or may even find a positive impact (e.g. Fahnestock & Detling 1999).

Table 6: Documented environmental impacts of horses (including Przewalski horses) in different habitat types across the globe

Ecological feature	Types of impact	Environments	References *Australian references **Australian montane/alpine/sub-alpine references
Negative impacts			
Soil	Increased compaction, resistance to penetration, erosion, soil loss	Sub-alpine	Dyring 1990** Whinam et al. 1994**
		Montane	Andreoni 1998** Summer 1986
		Arid / semi-arid	Beever & Herrick 2006 Beever et al. 2008 Davies et al. 2014
		Coastal dunes	De Stoppelaire et al. 2004
	Lower soil aggregate stability	Arid / semi-arid	Davies et al. 2014
	Impacts on ecological functioning (particularly water availability) resulting from soil impacts	Arid / semi-arid	Davies et al. 2014
Water	Damage to waterways including bank collapse, pugging and channel widening	Overview	Kauffmann & Krueger 1984
		Sub-alpine	Dyring 1990**, 1991** Hope et al. 2012** Whinam et al. 1994**
	Lower water quality including pollution and turbidity	Sub-alpine	Rogers 1991
		Arid / semi-arid	Berman & Jarman 1988* Beever & Brussard 2000
	Damage to peatlands including gullying, compaction, drainage, irreversible oxidation of peat profiles and increased vulnerability to fire	Sub-alpine, montane	Dyring 1990** Rogers 1991 Grover et al. 2005** Grover & Baldock 2010**
Trampling	Vegetation and networks of tracks	Sub-alpine	Dyring 1990**
		Arid / semi-arid	Beever & Brussard 2000

Ecological feature	Types of impact	Environments	References *Australian references **Australian montane/alpine/sub-alpine references
Negative impacts			
Manure	Large manure piles supress vegetation	Sub-alpine	Dyring 1990**
	Manure piles as 'invasion windows' for exotic plant species	Grasslands	Loydi & Zalba 2009 Campbell & Gibson 2001
Plants	Reducing plant species richness	Arid / semi-arid	Berman & Jarman 1988* Beever et al. 2003
	Changes to species composition and slow hydric successions	Sub-alpine	Dyring 1990** McDougall & Walsh 2007**
		Grassland	De Villalobos & Zalba 2010
	Increasing weed species	Global review	Ansong & Pickering 2013
		Sub-alpine	Rogers 1991
	Reducing plant and seed density	Arid and semi-arid	Davies et al. 2014
		Montane	Loydi et al. 2012
	Altered species composition	Grassland and peatland	McDougall 1989**, 2007** McDougall & Walsh 2007**
		Steppe	Van Staalduinen et al. 2007
Wildlife	Impacts on other species of wildlife	Estuarine	Levin et al. 2002
		Grassland	Zalba & Cozzani 2004
		Arid / semi-arid	Matthews et al. 2001 Beever & Brussard 2004
		Alpine herpetofauna	Meredith et al. 2003 Clemann 2013**
	Repression of peatland fauna including crayfish and rodents May assist other taxa (e.g. deer, marsupials) by increased access via horse trails	Sub-alpine	Whinam & Hope 2005**
Positive impacts			
Plants	Increased species diversity	Sub-alpine, montane, desert	Fahnestock & Detling 1999 Austrheim & Eriksson 2001 Fahnestock & Detling 2002 Ostermann-Kelm et al. 2009 Stroh et al. 2012
	Seed dispersal	Coastal dunes	Cosyns & Hoffmann 2005
Fire	Reduction of fire severity	Forest, sub-alpine, montane, semi-arid	Silvers 1993* Davies et al. 2015

Some methodological problems make interpretation difficult. Exclosure plots are often positioned to record impacts in very specific habitat types, which are not representative of damage across the range, and exclosure plots typically exclude other large grazers like deer (e.g. Linklater et al. 2002). For example, Beever and Brussard (2000) showed that impacts were greatest in areas with both cattle and horse grazing, suggesting synergistic effects.

Responses to horse grazing can vary across different spatial scales (Beever et al. 2008) as well as temporal scales. In addition, horse grazing may not only have direct, but also cascading impacts, and these seem to be largely hidden in, or absent from, the literature. For example, changes to wildlife can occur when wild horse grazing increases visibility of bird nests or refugia and/or increases the density of opportunistic predators (Zalba & Cozzani, 2004). Changes to vegetation induced by wild horse grazing can also change the physical and chemical properties of soils with consequences for soil dwelling invertebrates (Beever & Herrick 2006), small seed eating mammals, and reptiles (Beever et al. 2003, Duncan 1992).

Horses in similar alpine environments globally show a preference for mesic grassland flush zones (e.g. Linklater et al. 2000, Crane et al. 1997). Therefore, impacts on bogs and waterways are probably the greatest concern, particularly because they are important habitats for a range of Commonwealth and state threatened species (summarised in Robertson et al. 2015). Broad-toothed rats also depend on this habitat that is linked to degradation due to horse impacts (O'Brien et al. 2008). Studies specifically in the Kosciuszko ecosystem show a variety of impacts in wetlands and demonstrate that the environmental impacts of horses have been of concern for decades (Robertson et al. 2015). Robertson et al. (2015) summarise the physical impacts of horses on streams, wetlands and riparian ecosystems from a variety of studies mostly published as research reports, and their work confirms field observations made by the ITRG in February 2015 of significant current impacts on these features in KNP. Their conclusions are supported by research using exclosure plots (Prober & Thiele 2007). Some of the putative benefits of horses, such as reduction in fire severity, do not seem to be supported by studies of cattle grazing in the Alps (Williams et al. 2006, Williamson et al. 2014). Furthermore, studies on cattle grazing in the greater ecosystem of the Australian Alps show significant impact on alpine and sub-alpine sphagnum bogs (Wahren et al. 2001). In addition, Australian snowpatch herbfields, which are already under threat from climate change, need to be protected from the impacts of introduced mammals such as horses (Williams et al. 2015). As a consequence, in part, of damage through trampling and grazing by horses, the NSW Scientific Committee (set up under the NSW Threatened Species Conservation Act) has made Preliminary Determinations to support proposals to list the terrestrial orchids *Pterostylis alpina* R.S.Rogers and *Caladenia montana* G.W.Carr as Vulnerable Species (see NSW Scientific Committee 2015a, b).

Peatlands are a specific plant community-soil complex which are particularly well expressed in KNP (Hope et al. 2012) in the form of sphagnum shrub bog and sedge-restiad fens. The vegetation depends on deep, highly organic, peat substrate which accumulates over millennia in waterlogged conditions. Vegetation blocks watercourses, leading to pool complexes and specialised oligotrophic communities (e.g. Whinam & Chilcott 2002). Streams in peatlands usually have narrow deep channels that are highly sinuous. The multiple effects of horse trampling include creating straight channels that drain pools and the top layers of the peat. Horses follow channels and break down the peat banks, also draining the peatland (Hope et al. 2012). Peat that is exposed to wetting and drying experiences irreversible decomposition and shrinkage (Grover et al. 2005, Grover and Baldock 2010). It is also vulnerable to fire and entire peatlands can be lost. This in turn changes the interception of precipitation by the peatlands and results in more variable stream flows and greater transport of erosion materials downstream.

Selective grazing by horses can target not only sensitive peatlands and bogs, but also mountain valleys and their associated streams. Where localised removal of vegetation by horses exposes surface soil in these locations, rilling, gullying and surface erosion can be initiated or exacerbated. Areas with dispersible soils are known to be particularly vulnerable

(e.g. Crouch et al. 1986). However, although on-ground evidence exists for such processes, it is difficult to determine the extent and severity of erosion specifically induced by wild horse activity on catchment slopes and valley floors.

Numerous degraded sites are distributed across KNP where vegetation loss or active erosion occurs. These sites are associated with fire trails, transmission lines and areas of intense human activity, or are relicts of historic fire, grazing and construction. Rehabilitation of these sites often involves using straw bales, mulching and/or geofabric to protect the ground-surface from the effects of runoff whilst vegetation re-establishes. Such rehabilitation efforts can be disrupted or compromised by feral horses, and will not normally be undertaken where significant horse populations exist.

The accumulation of evidence that horses can cause degradation and loss of habitat has led the Victorian Government to list wild horses as a potentially threatening process (VIC Scientific Advisory Committee 2011; VIC Department of Sustainability and Environment 2012). Similarly, the Federal Environment Department has listed horse trampling, browsing and grazing as a threat to sphagnum bogs (DEWHA 2009).

3.1.3 Latest ecosystem impact study

ITRG considered the report 'An assessment of feral horse impacts on treeless drainage lines in the Australian Alps' prepared for NPWS in 2015 (Robertson et al. 2015). The report assesses the environmental impacts of wild horses across the Australian Alps at treeless sites above 1040 m altitude. The report describes a comparative field study of drainage lines where evidence suggests that wild horses are either present or absent. The report argues that previous studies of wild horses in Australian alpine regions have been spatially limited and that this is the first field study that has been undertaken at a landscape scale. The ITRG has reviewed the report and finds that it has produced a substantial body of evidence indicating that wild horses do have a significant negative impact on small drainage lines at high altitudes. It was conducted professionally and scientifically. Despite some minor methodological caveats, the study demonstrates that the impacts are real and that more data, or a revised study, would not alter that conclusion.

The report also uses previous studies to demonstrate that other habitats and ecosystems are also impacted by wild horses (Dyring 1990; Walter 2003; Bishwokarma et al. 2014). Despite the study's encompassing of alpine and sub-alpine regions of Victoria, NSW and the ACT, it focuses only on *treeless ephemeral* drainage lines (Robertson et al. 2015) within those regions. This focus should be noted and care taken not to extrapolate the findings across all drainage line types or types of impacts in other habitats. There are many other forms of drainage lines occurring within these landscapes in terms of not only vegetation, but also hydrological and geomorphic characteristics. These include, but are not limited to, flow regime, slope, stream energy, and surface–groundwater connectivity.

The ITRG concludes that impact studies such as this should be carried out at intervals into the future as a way of assessing management performance against the next Wild Horse Management Plan.

3.1.4 Do horses have a positive ecological impact in KNP?

Some stakeholders have suggested that wild horses can provide 'ecological services' by increasing or regulating species diversity, increasing soil nutrient status, and promoting cool fire conditions as a consequence of grazing (see Appendix B). There are however no such scientific results for Australia. In the absence of targeted research on this within KNP, evidence to support or refute this must be drawn from overseas studies (Table 6). Almost all of the comparatively few references come from Europe and North America. It is important to recall, however, that the flora in those places has had millions of years to evolve under exposure to hoofed mammals.

Increased species diversity with low-density grazing by livestock generally is well documented in the literature (Milchunas et al. 1988; Milchunas & Lauernoth 1993; Fahnestock & Detling 2002). This might also be applied to free roaming horses within areas of national estates and has been described for the Pryor Mountain Wild Horse Range in the US (Fahnestock & Detling 1999), although the influence of horse grazing was secondary to environmental factors of seasonal precipitation. Higher plant diversity occurs near wild horse faeces, and this is due to locally increased soil moisture, soil nutrient status, or higher density of viable seed passed with the faeces (Ostermann-Kelm et al. 2009). In some studies, the presence of horse faeces improved conditions for native species (Ostermann-Kelm et al. 2009), but others suggest that 'alien' or exotic species are favoured (Törn et al. 2010). Despite long-range effects of plant dispersal by horses, increased plant diversity occurs at small spatial scales. Furthermore, it is not clear whether such effects are maintained over time, or are simply short-term, opportunistic responses to locally favourable conditions. Studies in temperate fens in the UK indicate that, although long-range dispersal of viable seeds by wild horse grazing is an important form of seed dispersal, post-dispersal fate is controlled by a range of environmental factors (Stroh et al. 2012). The benefits derived from horse manure as a result of increased nutrient availability, particularly nitrogen and phosphorus (Dai 2000; Aarons et al. 2004), also appear to be highly localised and transient. They are likely to be accompanied by the increased risk of weed seed transport and establishment in dung (Törn et al. 2010; Loydi & Zalba 2009).

There is no literature that specifically examines the impact of wild horses on fire security, but research has been undertaken on grazing by cattle or mixed ungulate grazing. For example, the Honours thesis of Silvers (1993) found a reduction in fuel load under grazing from cattle and horses in the Barmah Forest. However, recent research examining the relationship between grazing and fire in the Australian high country has been prompted by the catastrophic fires of 2003, 2007 and 2009 across the alpine, sub-alpine and montane regions of Victoria, NSW and the ACT (Williams et al. 2006; Camac et al. 2013, Williamson et al. 2014). Those studies concluded that there is no reduction in fire severity in response to grazing. This outcome could be expected since cattle and horses preferentially graze on grasses which are significantly less flammable than heathland and woodland vegetation. Furthermore, under certain conditions, grazing pressure can increase shrub vegetation relative to grasses because of the greater palatability of the latter (Williams & Ashton 1988). During the 2003 fires, rather than generate 'cool fire conditions', areas with grazing licences experienced slightly higher fire severity (Williamson et al. 2014) probably due to preferential selection of green feed by cattle.

3.1.5 Conclusions – the environmental impact of horses

The ITRG concludes that the balance of evidence presented above strongly indicates that wild horses are having a significant negative environmental impact on Australian alpine and sub-alpine ecosystems.

3.1.6 Cultural value of horses

Key to the success of any management program will be to consider both ecological and human dimensions of wild horse management, which have been discussed in detail by Nimmo & Miller (2007). Globally, horses are an iconic species and consequently receive much public scrutiny and attention (e.g. Symanski 1994, 1996; Linklater et al. 2002). This underscores the cultural importance of horses, including in Australia (Walter 2002), with horses being iconic in folklore. Horses are symbolic of colonial times, as exemplified by, for example, *The Man from Snowy River*, and frequent cultural references to horses (e.g. in the Olympics, the $10 note, museum exhibitions). The well-loved *Silver Brumby* series of children's novels by Elyne Mitchell, were set in the KNP region.

There is a sector of the tourism industry in KNP that derives from horses. The ITRG noted the strength of feeling of some stakeholders about the cultural significance of horses in KNP and the contention that horses enhance social values within the park.

The ITRG had access to the draft report 'National cultural heritage values assessment and conflicting values discussion report' by the heritage consulting group *Context* (Context 2015). The report aimed to trace the 'history of the wild horse population and identified changing perceptions of this horse population'. In an extensive analysis of a range of historical materials, the consulting group assessed the KNP to have cultural heritage significance. An important point made by the group related to conflict arising from cultural heritage values, which they identified as arising from four key elements: interests, values, identities and rights. They noted two positions in relation to the KNP wild horse population: one that 'seeks removal of horses from the KNP and denies or minimises their cultural values' and the other position which advocates for 'the retention of the wild horse population and denies or questions claims of environmental damage'. The ITRG also noted this challenging divide which has a foundation in cultural heritage values. *Context* advised that 'finding commonalities, appreciating different perspectives and reducing the sense of identity threat' are helpful in resolving such conflict. The ITRG hopes that the *Context* report, which aims to take a scientific and dispassionate approach, while recognising the views of all stakeholders, will help to move all groups to a consensus in relation to the management of wild horses.

3.2 What is the relationship if any between horse numbers and impact on park values?

There is likely to be a relationship between local horse density and impact on the KNP environment. Areas that are heavily grazed usually show greater evidence of negative impacts (e.g. Berman & Jarman 1988, Beever et al. 2008). However, the ITRG could not refer to any established density–damage relationships and lacks evidence on which to deduce the form of this relationship for horses in KNP. Impacts occur on multiple spatial scales, but usually need management at a local level. The interaction between local density and local impacts is therefore particularly relevant, but we rarely have data to connect the two. While research may be able to fill this gap, it may be more productive to focus primarily on the effect of management interventions on indicators of environmental impact, rather than just horse numbers/densities. Lastly, the park manager has to assess the impact in the context of the relative importance of the asset. Indeed, in certain areas, in such an important park as KNP for conservation, it may be that *any* damage at all is unacceptable.

3.3 What are the best measures of success in reducing and/or ameliorating impact?

Studies on impacts need to be coupled with assessments of habitat preferences of horses, and local area densities. Any management program needs to focus on the desired outcome of reducing impacts, rather than reducing numbers *per se*. The measurable impacts will guide the advice on measures of success. Such measures could include:

- impact on flora, fauna and community structures, especially vulnerable or rare ecosystems or populations
- recovery of integrity of waterways
- improvement in water and peat retention in bogs
- prevention of damage to bogs (and recovery works)
- safety for park visitors while driving and walking
- amenity for walkers affected by high intensity horse damage, e.g. manuring, track damage, polluted water
- "good neighbour" principles for adjoining reserves, public and private land, and
- biosecurity including disease, transfer of propagules or pests.

As the management plan is implemented, a key task will be to agree on a selection of essential indicators and a process for monitoring them.

4. If horses have to be removed, what methods are currently or potentially available?

The ITRG has reviewed the range of control methods for horses and assessed their impact on animal welfare using an internationally recognised process. Three of the methods assessed were found not to be sufficiently humane for application in the park: roping (brumby running), loading and transport (long journeys), and aerial shooting where the horse cannot be rapidly shot. Where live horses are removed from KNP, we found that mustering (of small groups) and passive trapping offer the most humane approach of the live capture methods assessed. Transport of these horses should be kept to a minimum as short journeys were found to have less impact than long journeys. If lethal control is required, we found that best practice aerial shooting had the least potential adverse impact on wild horses, noting however that this is currently out of scope for KNP. This was dependent on a number of conditions being in place including suitable vegetation, adherence to specific standards and the use of highly trained and competent pilots and shooters. Where these conditions are not achievable, ground shooting, or passive trapping/mustering followed by on-site humane killing were the next best options.

4.1 Overview of control methods for wild horses

A range of different methods exists for the control or removal of wild horse populations, including non-lethal methods such as exclusion fencing, fertility control or removal of horses for domestication, and lethal methods such as in situ shooting or removal for slaughter in an abattoir or knackery. At present, the only method employed in KNP is passive trapping followed by removal of horses for either domestication or slaughter. The outcome for the majority (70%) of horses removed via trapping is slaughter in an export abattoir or knackery, with only 30% of horses being 'adopted' for domestication.

Consideration of any method to control or remove wild horses from KNP necessarily needs to take into account many different factors, including efficacy, cost, practicality, operator safety, target-specificity, environmental impact, as well as its impact on the welfare of the affected horses, also termed *humaneness*. For some stakeholders, the humaneness of a control method is the single most important aspect of managing wild horses. The ITRG is also required under its terms of reference to assess the various control methods for their level of humaneness.

4.2 Assessing the humaneness of different control methods

For many years, a major stumbling block in the consideration of animal welfare in wildlife management was the lack of a reliable and practical method of assessing it. In 2007, with the support of the Department of Agriculture, Fisheries and Forestry under the Australian Animal Welfare Strategy (AAWS), a project was funded to develop a process for assessing the relative humaneness of pest animal control methods. Under the management of a steering group formed from members of the AAWS Wild Animals Working Group, the NSW Government's Vertebrate Pest Research Unit was commissioned to develop a suitable model for humaneness assessment. The model was first published in 2008, with a second edition in 2011 (Sharp & Saunders 2011). The model has now been used to assess numerous pest animal control methods for a range of species in Australia (Hart et al. 2013; Sharp & Saunders 2008, 2011), New Zealand (Fisher et al. 2010) and the United Kingdom (Baker et al. 2016). The ITRG decided to adopt this method to assess the humaneness of different methods of horse control in KNP. The full report from the ITRG's humaneness workshop can be found in (HAP, 2015). What follows is a summary of relevant findings.

4.3 Humaneness assessment model applied to horses in KNP

Panel members for this assessment had expertise in horse behaviour, horse ecology, animal welfare, animal ethics, humane wildlife capture and killing methods, equine medicine and horse performance, conservation, wildlife and pest animal management. The panel was made up of nine members in total, including three members of the ITRG, five independent members appointed for their specific expertise, and a member of staff from NPWS to provide background information on KNP (see HAP 2015).

All assessments were carried out using the 2011 edition of the *Model for assessing the relative humaneness of pest animal control methods* (Sharp & Saunders 2011). The model provides a practical, general means of assessment that can be applied to any control method. The goal of humaneness assessment is to evaluate the impact of a control method on individual animals and to use this assessment to determine which methods are more or less humane compared to other methods.

The assessment of overall welfare impact is based on five domains:

1. Thirst/hunger/malnutrition
2. Environmental challenge
3. Injury/disease/functional impairment
4. Behavioural/interactive restriction
5. Anxiety/fear/pain/distress.

The model was not designed to provide an absolute measure of humaneness but allows a judgement to be made about the impact of a specific control method on the target animal. When the model is applied to a range of different methods, these can be compared and a decision can be made on the choice of method that is informed by an understanding of the relative humaneness of each method being considered.

The model uses a two-part assessment process for each method:

- Part A examines the impact of a control method, which may or may not be lethal, on welfare, and the duration of this impact.
- Part B applies to lethal methods only and examines the effects of the killing method on welfare by evaluating the intensity of suffering and duration of suffering caused by the technique.

Both Part A and Part B are used to assess the overall humaneness of lethal control methods. For non-lethal methods, only Part A is used to examine the impacts on an animal's welfare.

With Part A, the impact in each of the five domains is assigned a grade (ranging from no impact to mild, moderate, severe, or extreme impact), and from this an overall impact grade and duration of impact are determined. With Part B the level of suffering is graded and the duration of suffering determined. Impact scores are assigned using a predetermined scoring matrix (Boxes 1 and 2).

Where there are multiple stages in a process, the model can be used to assess the impact of each stage the animals go through from the application of the first method to a specific end-point.

There is often a paucity of published peer-reviewed literature on the application of control methods for wildlife and pest animal management. A lack of objective data means that there is always some reliance on subjective data such as advice from experienced practitioners and comparisons with other similar species. It is important that those performing the assessment have an understanding of the biology and behaviour of the target species as well as knowledge and experience of practical aspects of the control method being assessed. The composition of the panel should ensure that there is a wide range of relevant experience and knowledge that can be drawn on during the assessment process.

Assumption of 'best practice'

Best practice pest animal control methods as defined by standard operating procedures (SOPs) describe the requirements of implementing a specific method in terms of humaneness, target specificity, efficacy and cost effectiveness, as well as operator health and safety (see Sharp 2011a, b, c, d). When assessing the impact of a control method in each of the domains a key assumption is that the method is being carried out according to 'best practice'. This is to ensure that the evaluation is of the intrinsic humaneness of a method rather than technical inadequacies or limitations associated with its application. Best practice application also assumes that those carrying out the technique are sufficiently skilled, competent and experienced to be able to consistently and effectively achieve best practice outcomes.

Box 1: Scoring matrix for Part A: overall welfare impact

	Duration of impact				
Overall impact on welfare	**Immediate to seconds**	**Minutes**	**Hours**	**Days**	**Weeks**
EXTREME	**5**	**6**	**7**	**8**	**8**
SEVERE	**4**	**5**	**6**	**7**	**8**
MODERATE	**3**	**4**	**5**	**6**	**7**
MILD	**2**	**3**	**4**	**5**	**6**
NO IMPACT	**1**	**1**	**1**	**1**	**1**

Box 2: Scoring matrix for Part B: assessment of mode of death

	Time to insensibility (minus any lag time)				
Level of suffering[a]	**Immediate to seconds**	**Minutes**	**Hours**	**Days**	**Weeks**
EXTREME	**E**	**F**	**G**	**H**	**H**
SEVERE	**D**	**E**	**F**	**G**	**H**
MODERATE	**C**	**D**	**E**	**F**	**G**
MILD	**B**	**C**	**D**	**E**	**F**
NO IMPACT	**A**	**A**	**A**	**A**	**A**

[a] After application of the method that causes death but before insensibility

In determining the scope of the humaneness assessment, the panel considered all potential methods listed in Table 1 of the 2008 KNP Wild Horse Management Plan (DECC 2008). Assessments were then conducted based on the availability of documented standards or SOPs for these methods and the available scientific literature and experience in the application and outcomes of these methods. Assessments were conducted for each method and outcome where sufficient information existed to be able to define best practice application of the method.

Some control methods are single-stage methods and thus only required one assessment, while others such as removal of horses for humane killing, slaughter or domestication, are multi-stage processes. In the case of multi-stage processes, separate assessments were made for each different stage.

The panel examined 11 different control methods or stages in the management of wild horses. Three of these could not be assessed, or were only partially assessed, due to lack of a SOP or its equivalent (Figure 1).

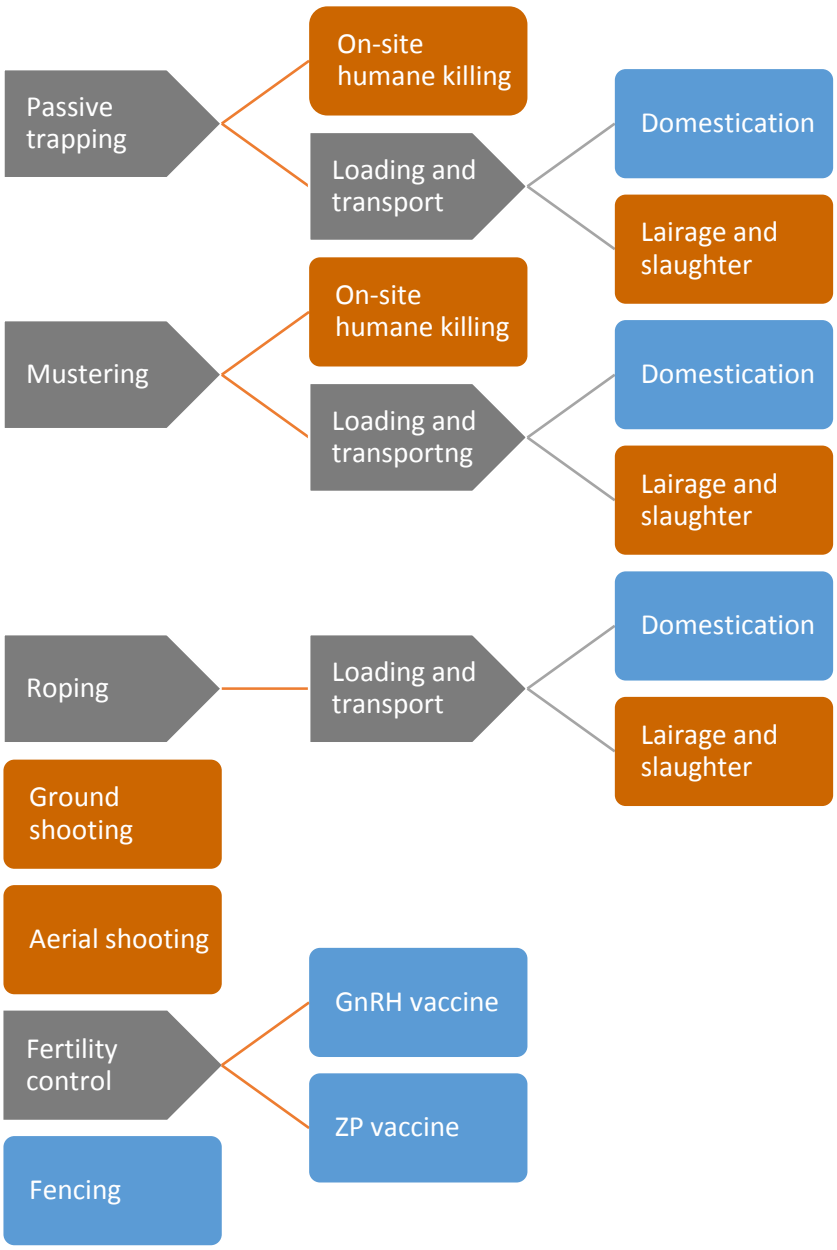

Figure 1: Single and multi-stage wild horse control methods and their outcomes
Orange boxes indicate lethal outcomes; blue boxes indicate non-lethal outcomes.

4.4 How do the available methods compare in terms of humaneness?

Detailed information on the assessment of each control method, including notes, assumptions and a summary of evidence, is provided in the Humaneness Assessment Report, (see HAP 2015).

Each assessment was based on a number of specific assumptions including that the method is carried out by skilled, competent and experienced operators in accordance with best practice through compliance with a SOP. Where no SOP existed, the panel used the best available information to guide the assessment. It is important to note these assumptions when considering the relative humaneness for any given method, as any deviation from them will alter the outcome of the method (see Appendix C). Some methods, such as those that include the risk of free-running animals becoming injured without being able to be followed up, have the potential to result in significant adverse impacts if best practice is not followed. It is likely that those methods that do not meet the requirements of best practice will result in poorer animal welfare outcomes than indicated here.

A summary of the assessment scores is shown in Table 7. All potential methods for the control of wild horses were found to have some adverse impact on horse welfare. Three of the methods assessed were found to have severe adverse animal welfare impacts: roping (brumby running), loading and transport (long journeys) and aerial shooting (Scenario 2). The remaining methods were assessed as mild or moderate in their impact, with the final score dependent on the potential duration of these impacts.

Choosing appropriate methods should therefore require careful consideration of how to mitigate those impacts. The severity and duration of impact both affect the final score, thus a long-lasting method with a mild impact can result in the same score as a faster-acting method with a severe impact.

Lethal methods

Where lethal control is required, the assessment indicated that aerial shooting (Scenario 1) had the least potential adverse impact on wild horses. This scenario was dependent on a number of conditions being in place in addition to the requirements of the existing SOP. The difference between the aerial shooting assessment scores for Scenario 1 versus Scenario 2 demonstrates the importance of ensuring best practice through adherence to specific standards and the use of highly trained and competent pilots and shooters.

Where the conditions stipulated for aerial shooting (Scenario 1) are not possible, ground shooting (head shots), or passive trapping/mustering (small groups) followed by on-site humane killing had the next lowest assessment scores, although the impact of on-site killing requires further assessment and is dependent on the development of an acceptable methodology and SOP.

In the case of aerial shooting, a number of specific conditions (over and above those set out in the relevant SOP) were identified that were considered more likely to result in a best-case scenario welfare outcome for shot animals. These were:

- using highly experienced and skilled shooters and pilots
- ensuring that the point of aim for the first shot is always the cranium; if the first shot cannot be accurately placed then a shot is not fired
- shooting occurs only in open areas with minimal high-canopied vegetation (tree cover or woodland)
- shooting in flat terrain rather than steep or undulating areas as this will result in fewer injuries and allow for easier sighting of wounded animals
- shooting in cooler temperatures to minimise heat stress in pursued animals
- small groups of horses (<10) are targeted at a time; congregations of social groups in larger mobs are avoided.

Table 7: Assessment scores for each control method and stage

Please refer to the worksheets in Appendix B of the Humaneness Assessment Report (HAP 2015) for details of assumptions and evidence used in the assessment of each of these methods.

METHOD	PART A			PART B		
	Impact	Duration	Score	Impact	Duration	Score
Passive trapping	Moderate	Hours	5			
Mustering (small groups)	Moderate	Hours	5			
Mustering (large groups)	Moderate	Days	6			
Roping (brumby running)	Severe	Hours	6			
On-site humane killing	*Not assessed*			None	Very rapid	A
Loading and transport (short journeys)	Moderate	Hours	5			
Loading and transport (long journeys)	Severe	Days	7			
Domestication	*Not assessed*					
Lairage/holding	Mild	Days	5			
Slaughter	Moderate	Minutes	4	None	Very rapid	A
Ground shooting (head shot)	Mild	Days[a]	5	None	Very rapid	A
Ground shooting (chest shot)	Mild	Days	5	Moderate	Minutes	D
Aerial shooting (Scenario 1)[b]	Moderate	Minutes	4	None	Very rapid	A
Aerial shooting (Scenario 2)[b]	Severe	Minutes	5	Severe/ extreme	Very rapid/ minutes	D
Fertility control delivery	*Not assessed*					
GnRH vaccine	Mild	Weeks	6			
PZP vaccine	Mild	Weeks	6			
Fencing	Mild	Days	5			

[a] Note that the duration for ground shooting is given as days, whereas minutes are given for aerial shooting. This is because the panel considered the impact on the band of horses being targeted and not just the individual horse that was shot. In ground shooting, only one or two horses are usually shot at a time, as the others will disperse and cannot be easily followed up on the ground. This means there will be behaviour adjustments/impacts in the band over the next few days. This does not occur in aerial shooting where the whole band is rapidly targeted and killed.

[b] Scenario 1(best case) is where horses are chased for <1 minute, are rendered insensible with the first shot and do not recover consciousness prior to death; Scenario 2 is where horses are chased for >5 minutes, are not effectively rendered insensible with the first shot and are shot again resulting in death.

Non-lethal methods

Where wild horses are removed from KNP for potential domestication, the assessment indicates that mustering (small groups) and passive trapping offer the least humaneness impact of the live capture methods assessed. Transport of these horses should be kept to a minimum as short journeys were found to have less impact than long journeys. The impact of

domestication procedures is unknown but will obviously depend on the skill and approach of the trainers involved.

The assessment scores indicate that there is a relatively high cumulative adverse impact where horses are trapped, transported, held and then further transported to an abattoir for slaughter, especially where this involves a long journey. Where horses are captured but are found unsuitable for rehoming, the assessment indicated that on-site humane killing is relatively more humane.

There was no difference in the relative animal welfare impact of the two immunocontraceptive vaccine fertility control methods assessed. While the impact of fertility control was found to be mild, there is a range of effects on individual and group behaviour which can last for weeks. The science around the use of fertility control in the management of wildlife populations is far from complete. Further research is needed to determine how effective it is in the long term, how best to deliver fertility control and the impact of the delivery method itself.

The impact of fencing was found to be mild, but likely to last for days. However, this will vary according to the scale of fencing (e.g. exclosure of a small protected area compared to large-scale fencing of roads to prevent movement) and would reduce over time as horses became habituated to fencing.

When considering the overall impact of a multistage process, all stages must be considered, as the cumulative effects of each procedure will compound the overall welfare impact. Where initial methods have similar scores, the adverse impact of those methods involving multiple stages will be greater than those with only one stage. For example, the cumulative impact of the process of passive trapping, loading and transport to a holding area, long-distance transport to an abattoir, lairage and slaughter has a much higher welfare impact than ground or aerial shooting. Thus, in seeking the most humane outcome, it is important to minimise the number of stages involved wherever possible. For example, this can be achieved by reducing the number of times horses are subjected to loading and transport, or in the case of lethal methods, by humanely killing horses in situ rather than transporting them to an abattoir to be killed.

Given the importance of ensuring best practice in improving the relative humaneness of control methods, consideration should be given to implementing an auditing or inspection process to measure compliance.

5. What are the options for management of wild horses in KNP?

In developing options for future management of horses, the ITRG has considered the evidence on numbers of horses, their impact on the park, both positive and negative, and the various potential methods of control. Using recognised scientific criteria, the ITRG has found that complete eradication of horses from KNP is not achievable, although horses may be excluded from certain parts of the park. On the other hand, the evidence of ecological harm is sufficient for the ITRG to conclude that wild horse populations in KNP must not be left unmanaged. This conclusion was echoed by a majority of stakeholder organisations, including some of those who are essentially pro-horse. Lastly, the ITRG found that combining various control methods, and setting different levels of permissible horse impact for different areas of the park, would be the most effective way of managing horses in such a way as to minimise environmental harm.

5.1 Overview of issues considered

The following section provides ITRG management recommendations for consideration in the development of the KNP Wild Horse Management Plan. It integrates our findings with those of the community consultation process, the heritage assessment and the stakeholder submissions. As part of the ITRG process certain guiding principles were followed. These include best practice in vertebrate pest management (e.g. Braysher et al. 2012), biosecurity (NSW Government 2013) and animal welfare (Sharp & Saunders 2015). The ITRG also recognises that it is making its recommendations based on present facts and that the dynamics of wildlife populations and their impacts can change over time. For this reason, adaptive management, where the impact of management decisions is monitored and the results fed back into future decision-making, must be applied (Allan 2007; OEH 2015). Finally, the ITRG makes its recommendations on the understanding that the implementation of a long-term management plan for wild horses in KNP will require a long-term budgetary commitment by the Government.

5.2 Is eradication of wild horses from KNP feasible?

For those concerned about the impacts of wild horses on park values, eradication from KNP may be an appealing option. Furthermore, conventional pest control techniques could be stopped if eradication were achieved, decreasing concern over moral and animal welfare issues (Bomford & O'Brien 1995). However, while there have been many examples of successful eradication campaigns against introduced vertebrates on islands, there are no such examples from continents (Bomford & O'Brien 1995; Simberloff 2003). In the case of horses in KNP, we have reviewed the prospects for eradication against criteria (Table 8) that have been developed for vertebrates (Bomford & O'Brien 1995) and for introduced species (vertebrates, invertebrates, plants and diseases) generally (Simberloff 2003).

Using either set of criteria in Table 8, the ITRG agreed that whatever management methods are implemented, complete eradication of wild horses from KNP is not a realistic or achievable aim or objective with currently available control methods and technologies, even if these are not resource-limited. We thus conclude that managers must live with a long-term presence of horses in KNP, although it is likely that eradication from areas within the park from which horses are excluded may be achievable (see next sections). Therefore, any management plan should assume that wild horses will remain in some areas of KNP and should focus on determining priorities for reducing wild horse densities and their impacts in areas where they currently occur. However, the ITRG considers that areas which are currently horse-free, have very low densities or small isolated populations of horses, could be maintained as horse-free or managed towards a horse-free state (local eradication). It logically follows that these areas would be prioritised for management effort. Factors to consider in this process include the capacity to reduce adverse environmental impacts associated with the presence of wild horses and the risk and potential of existing populations expanding into current horse-free areas.

Table 8: Assessing the prospects for eradication of wild horses from all of KNP

Criterion	Do wild horses in Kosciuszko meet the criterion?	Comments
Bomford & O'Brien (1995)		
1. Rate of removal must exceed rate of increase at all population densities (essential)	Probably	KNP is suitable horse habitat so rates of increase may well be relatively high.
2. Immigration into the eradication area can be prevented (essential)	No	Immigration from outside the park would be very likely.
3. All reproductive animals must be at risk from control measures (essential)	No	Depending on control method, horses could rapidly become very shy.
4. Animals can be detected at low densities	Yes	Generally true, though as horses become shy and retreat to forests, their detection rate would fall.
5. Discounted benefit–cost analysis favours eradication over control	Unknown	Quantifying environmental harm is difficult, rendering the benefit–cost analysis questionable.
6. The socio-political environment is suitable	No	The chances of achieving a societal consensus favouring complete eradication are minuscule.
Simberloff (2003)		
1. Resources must be adequate to complete the eradication	No	Because mammal removal rates decline exponentially as densities are reduced, and horses are so widespread, the resources required would likely never be adequate.
2. Clear lines of authority must be established	No	This is Simberloff's equivalent of Bomford and O'Brien's No. 6, implying a consensus that gives authority to an agency to prosecute the eradication.
3. The biology of the species must be appropriate	Yes (conditional)	Simberloff contrasts large mammals with small insects and plants with seed banks. Horses would be easier to eradicate (in terms of biological attributes) than a weed with a long-lived seed bank, but other difficulties may intervene.
4. The target species must be detectable at low densities	Yes	See No. 4 of Bomford and O'Brien above.
5. Management resources would be available to follow up the eradication attempt	Yes	Eradication is a large uncontrolled experiment and we need to be prepared for unforeseen consequences. If eradication were attempted, NPWS would likely do this in the context of a long-term plan.

5.3 What are the options for acceptable densities, regional distributions, and impact?

5.3.1 Is doing nothing an option?

While eradication from KNP is not a viable option, nor is the opposite extreme of doing nothing. The ITRG finds that wild horse populations must not be left unmanaged in KNP. There is sufficient evidence of ecological harm to require management intervention. It was also agreed by the ITRG that using an integrated range of control methods, rather than limiting control to a single method, would provide the best and most efficient opportunity for achieving population reduction and associated mitigation of impacts. It should also be noted that control techniques can be suited to differing types of vegetation and terrain with implications for humane outcomes (Dobbie et al. 1993).

In order to make any effective reduction in current horse populations and their impacts, a range of control methods are needed that have the capacity, in combination, to remove large numbers of horses over a relatively short period of time, with sustained follow up and maintenance. The model code of practice for the humane control of feral horses and related SOPs, endorsed by the NSW Department of Primary Industries, provide information on how to choose and apply methods for reducing the negative impact of feral horses (Sharp & Saunders 2015). All control methods will require significant investment so they can be maintained over the long term in order to achieve a sustained reduction in wild horse densities.

5.3.2 What is an acceptable density?

There are no density/damage relationships for different ecosystems within the park. Setting density thresholds is a challenging task technically, and has risks (see NZ Government 2006, Chapter 9):

> *A strategy of selective horse control is based on the premise that there is a population density below which the horses' undesirable effects are acceptable, i.e. a threshold level. A threshold population density is in turn linked to a threshold level of effect. Threshold levels of effects would be suitable performance standards for control operations, especially if they could be monitored using indicator species, vegetation stature or composition. For example, monitoring of vulnerable plant species is based on the assumption that, providing these key indicators are not being visibly or measurably damaged by horses, it is likely that the ecosystem as a whole will retain its integrity.*
>
> *In practice, such thresholds have been experimentally confirmed for few feral populations. Present knowledge suggests that thresholds vary markedly between ecosystems and even individual communities. The linkage between threshold impact and population level is unlikely to be linear and therefore impact thresholds are difficult to calibrate. Once threshold population - impact levels are known, definite target densities can be set in different plant communities.*
>
> *With present levels of understanding of ecosystem dynamics in N.Z., the only practicable approach to establishing impact thresholds would seem to be empirical monitoring of ecosystem responses to different horse population levels. Such an approach is of course long term and, in the case of critically threatened plant species and ecosystems, potentially very risky.*

Thus, it may be preferable to adopt thresholds of concern, i.e. with an emphasis on impact-based thresholds for action rather than density-based, although there would always be a need for some understanding of prevailing horse densities to ensure that the damage is being correctly attributed to horses. In general, the ITRG concludes that it would be advisable to reconsider the overall approach to horse survey strategy in KNP, perhaps under the auspices of an expert advisory group, formed for a limited duration to provide guidance to the management plan.

5.3.3 Impact-based options

Should an emphasis on impact-based thresholds for action be seen as the way forward, options OEH may wish to consider are:

- setting appropriate control strategies for each of the agreed regions and zones
- a shift of resources away from aerial survey of horse numbers to evaluating the effect of management on environmental impacts of horses
- defined 'heritage' areas for horses to be exposed to minimal management (possibly with buffer zones to contain horses within these areas)
- creating exclusion zones, e.g. along highways and major roads, or very sensitive habitats, and imposing buffer zones around these zones, and
- maintaining densities according to animal welfare goals in order to reduce the need to cull large numbers.

5.4 Stakeholder submissions to the ITRG

Stakeholders were invited to submit research, information or evidence to the ITRG on:

- wild horse numbers and distribution across the park
- wild horse impact on the park's values
- wild horse population control methods, and
- wild horse population management objectives for the park.

The ITRG received 32 submissions from individuals or stakeholder groups. In addition, the ITRG spent a day receiving oral presentations from stakeholders on 26 March 2015. Much of the material received was conjectural in nature, rather than strictly conforming to the request for research, information or evidence.

A significant majority of stakeholder organisations, even those who are essentially pro-horse, thought that some control of wild horses was necessary in KNP. A number of stakeholders who are advocates for maintaining wild horses within the KNP recognised the need for management of horse numbers, and argued for an array of management measures. Many pro-wild horse advocates felt that brumby running is unacceptable as a control measure. This was also a finding from the ITRG humaneness workshop. The method imposes a number of risks to horses and riders, has potential negative welfare impacts on horses, and there is a limited number of wild horses that could be removed this way.

In common with many stakeholders, the ITRG would like to see fertility control methods researched and improved in efficacy. The ITRG supports the trapping and rehoming of wild horses as a control measure, while noting the severe limitations in the numbers that can be successfully rehomed in Australia (see National Research Council 2013). The ITRG differs from some of these groups, however, in concluding that aerial shooting, if carried out according to best practice, is effective and humane as a control measure, although it has been ruled out of the new management plan.

The ITRG does not find the argument convincing that horses merely replace the extinct marsupial megafauna of the region, and that horses therefore should be allowed unfettered access to KNP. It is simply not realistic to envisage, as a desirable management goal, returning KNP to a state that existed during the Pleistocene, around 46,000 years ago. Even if it could be proved that horses individually were a functional replacement for the extinct Australian megafauna (a long bow, given the broad diversity of the extinct species), there would remain the question of what densities horses should be maintained at, to give the equivalent grazing pressure and trampling effect of those long-vanished herds. In addition, the causes of extinction of the original megafauna are not well understood, and may actually have been a consequence of resource over-exploitation by that same megafauna.

Additionally, there is no suitable predator available to regulate the horse herds, something that would be necessary if we were to implement the Pleistocene ecological state. KNP must now be managed as an ecosystem facing considerable uncertainty under a changing climate, and the 'Pleistocene approach' would raise many unanswerable questions for managers, with little obvious benefit.

There were a number of stakeholders whose preference was for complete eradication of horses from the park. As the ITRG argues above (see Section 5.2, *Is eradication of wild horses from KNP feasible?*), eradication is simply not realistic or practicable in KNP, except at local scales. In addition, conducting a park-wide eradication policy denies what has been found to be a legitimate heritage value for wild horses in the region (Context 2015).

The ITRG supports the argument of Animals Australia that humaneness is a key factor in deciding on which control measures to use, and indeed it conducted a workshop to consider and categorise different control methods according to humaneness criteria (HAP 2015).

Regarding the proposal by StockWHIP on wild horses for prisoner rehabilitation, this seems to be potentially a valid way of preparing horses for rehoming, although likely to be a significant additional cost to government. However, as a means of controlling horse numbers in KNP, the limiting factor of the number of available rehoming opportunities for retrained horses still applies, and the ITRG concludes that this approach, while potentially beneficial for prisoner rehabilitation, would consequently have only minimal impact on the horse populations in KNP.

The stakeholders raised a number of other questions which have been considered by the ITRG and either addressed in the work already undertaken or considered in the research priorities outlined in this report. Stakeholder submissions are dealt with in more detail in Appendix B.

5.5 What scientific criteria could NPWS use to prioritise different zones for management of horses?

5.5.1 Regional subdivisions of KNP

Three key management regions under consideration by NPWS are endorsed by the ITRG (Figure 2). These regions were demarcated by public roads and topography and took account of the current distribution of horse populations and areas of presence and absence of horses within the park:

- **Northern KNP** (290,000 ha) – all areas north of the Snowy Mountains Highway, Link Road and Khancoban–Cabramurra Road. This includes the highest density of wild horses in the park, predominantly around the grassy plains in the east around Long Plain, Tantangara, Currango and Cooleman Plain. There are also areas such as Nungar Plain which have very low numbers of horses that have only been established in recent years. These areas could be designated as a priority for management if it is feasible to reinstate and maintain them as horse-free areas.
- **Central KNP** (230 000 ha) – includes the Main Range Management Unit, Jagungal and western Fall Wilderness and Snowy Plain. This region is delineated on its northern perimeter by the Snowy Mountains Highway from Adaminaby to Kiandra, the Link Rd from Kiandra to Cabramurra, and the Cabramurra to Khancoban Rd. The southern boundary of Region 2 is delineated by the Alpine Way as it crosses the park along the Thredbo Valley from Jindabyne in the east to Tom Groggin and Khancoban on the western side of the park. This region has relatively low densities of wild horses in the Snowy Plain and Main Range areas along with incursions from the Northern Region in the Mt Selwyn/Four Mile Ridge area. Large areas of the region are currently horse-free.

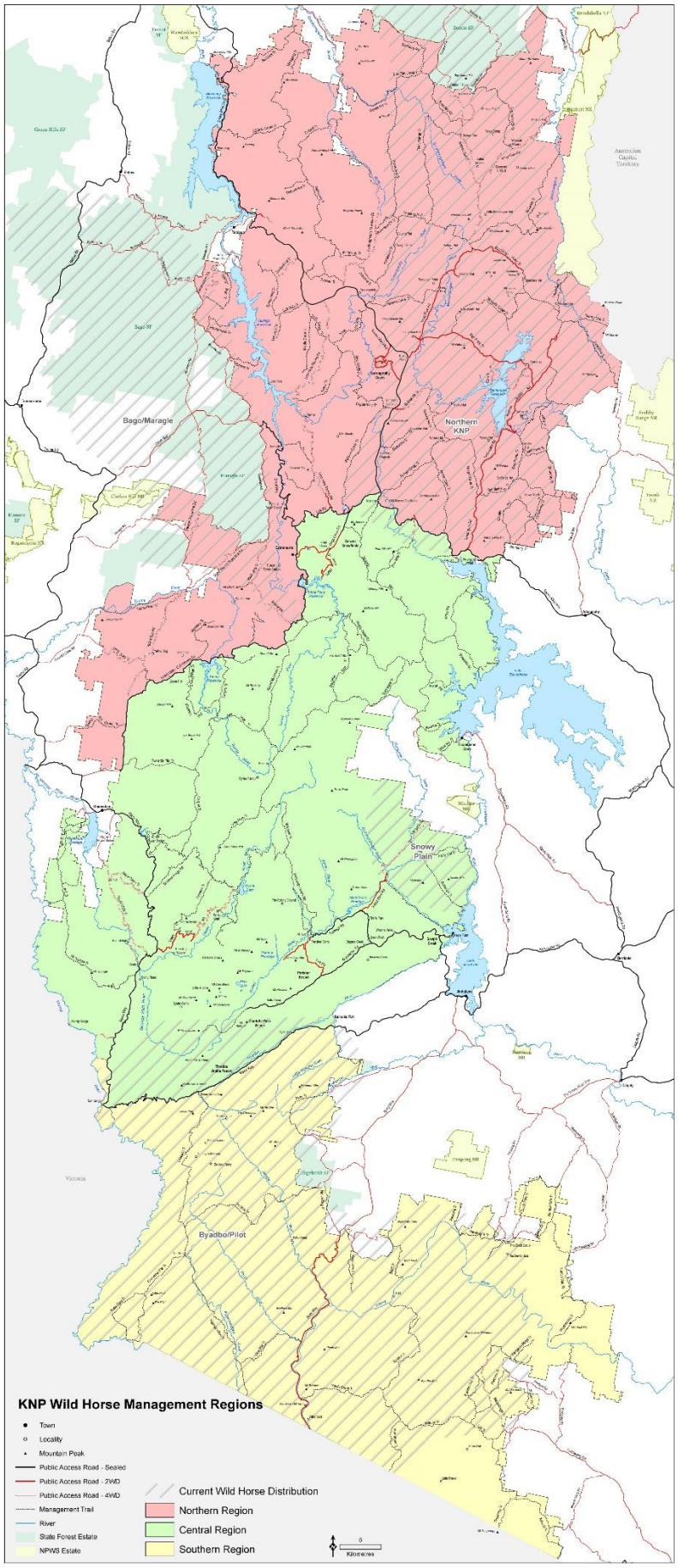

Figure 2: Map of KNP wild horse management regions

- **Southern KNP** (170 000 ha) – including the Byadbo and Pilot Wilderness area, from the Alpine Way to the Victorian border being the Murray River in the west and the Black–Allan Line in the south. Wild horses occur at medium density in the plains and grassy areas around water sources associated with frost hollow valleys and clearings within the open forest areas in this region and along the Lower Snowy River corridor. The elevated sub-alpine plateau of the Upper Thredbo River, Chimneys Ridge and Brindle Bull areas currently supports medium to high density wild horse populations. Annual mark–recapture aerial surveys in this area have returned population estimates of 80–190 horses with estimates of 2.01–5.45 horses per km^2. Horses are known to traverse the steep forested areas of the Upper Murray or Indi River valley, as well as the similar steep forested areas in the Pinch and Jacobs River valleys, but this is not regarded as optimal habitat, particularly as a result of relatively dense understorey regrowth after the 2003 fires.

5.5.2 Subdividing the three regions – scientific criteria

The ITRG concludes that under best practice, the above regions need to be further subdivided into zones within which horse numbers can be managed to different levels, to facilitate resource allocation, coexistence of different values within KNP, prioritisation of management actions, and longer-term planning.

Environmental management decisions are usually a compromise or trade-off between competing pressures. Here the ITRG presents a set of scientific criteria that may be used by NPWS in creating zones within its three identified KNP management regions. These criteria cannot all take equal weight, and some may run counter to others in certain circumstances, so their application is down to judgement by NPWS managers. However, the ITRG considers that there are also certain threatened ecological communities requiring protection, distributed across the park, whose conservation should, under any normal circumstances, override any subdivisions emerging from these criteria.

The key prioritisation criteria include:

- vegetation, e.g. unique habitats and endangered ecosystems
- flow-on effects, e.g. impacts on waterways may affect water quality downstream
- where application of specific control options can be maximised in terms of humaneness, feasibility and effectiveness, e.g. control options are best suited to appropriate vegetation types
- current distribution and density of horses throughout the park
- regions and zones set at manageable size so that control targets can be met and performance monitoring can be implemented
- selection takes into account biosecurity approaches, i.e. eradication, prevention, containment and asset protection
- selection takes into account nil-tenure issues, e.g. off-park wild horse populations, and
- selection takes into account public safety issues, e.g. road safety.

In terms of prioritising specific areas based on ecological vulnerability, the ITRG recommends emphasis be placed on conserving the following threatened communities:

- higher altitudes – alpine and sub-alpine
- wetlands and peatlands
- herbfields, and
- specialised grasslands.

Specific areas that should be targeted for protection as part of any prioritisation process include:

- Main Range and other high altitude areas (including Charcoal and Chimney Ranges, Pilot Wilderness, Jounama, Bimberi/ACT border)
- Kiandra grasslands, and
- large sedge-lands in the north within Long Plain, Coolamon, upper Tantangara and Nungar Plains.

5.6 External interactions with KNP

The following points should also be considered in the development of a management plan:

- Horses will spread from KNP populations to other land tenures, potentially impacting on near neighbours including the ACT, private landholders to the east and west, adjacent forestry land and the Victorian Alpine Park.
- Management regions and zones within KNP will be compromised by immigration from neighbouring areas (with potential for introducing weeds). Areas of concern include the Victorian Alpine Park, Maragle and Bondo State Forests, Yaouk and Bugtown (east of Nungar Plain).
- State agencies, e.g. State Forests and Victorian National Parks, should coordinate horse management strategies with NPWS.

5.7 Application of control methods across diverse landscapes

5.7.1 Integrating humaneness with management context

Assessing the humaneness of a pest animal control method is just one step in evaluating the suitability of a method for a particular situation. Decisions on the specific need for management or use of particular control techniques require that multiple criteria be considered. These may include: efficacy, target specificity, cost-effectiveness, feasibility, regulation, acceptability to the public, occupational health and safety and environmental impact (Sharp & Saunders 2011).

Many of these criteria are well-documented with respect to wild horse control methods (Sharp & Saunders 2011; Dobbie et al. 1993) and have been presented in previous iterations of the KNP wild horse management plan. With the exception of fencing, all methods considered by the ITRG are regarded as low risk to non-target species when applied to wild horses. Where control methods have the potential to have adverse impacts on environmental values in a given area of the park, this must be weighed up against the potential benefit of removal of wild horses. Issues of cost, in terms of the resource implications in the application of control methods, were not part of the assessment undertaken by the ITRG, but will need to be considered in the development of the management plan. Public acceptance and/or community attitude to different potential control methods or approaches varies, as indicated in the stakeholder submissions. The information presented in this report may assist in informing future attitudes to these methods. The following sections focus on where application of specific control options can be maximised in terms of humaneness, feasibility and effectiveness.

5.7.2 Control methods assessed in a management context

Aerial mustering and **aerial shooting** both offer the potential to remove large numbers of horses over a relatively short period of time, but their relative humaneness and effectiveness depends on the terrain, vegetation structure and scale at which they are conducted. Aerial shooting has been ruled out of the management plan currently under development, but in the opinion of the ITRG, should be considered for incorporation into future plans.

The humaneness assessment process determined that best practice mustering is only possible where horses are mustered over relatively short distances (2–4 km) within their home range into an open, flat central area. Road and transport access to the mustering yard is also required unless horses are humanely killed in situ. Mustering should only be undertaken in cooler periods of the year, (ideally in autumn) to remove the risk of heat stress and avoid mobs with heavily pregnant mares or mares with young foals at foot.

While mustering was approved under the 2008 KNP wild horse management plan, mustering operations have not been carried out to date in KNP other than logistical pre-planning and testing movement responses to helicopters of small mobs of horses. NPWS helicopter pilots have the appropriate CASA air operations mustering training and rating to undertake such work, and are experienced in using this technique for goats and cattle in other conservation areas across NSW and Australia.

Best practice requirements for aerial shooting requires targeting small groups of horses in relatively flat, open areas with minimal high-canopied vegetation (see HAP 2015 for specific criteria). Currently aerial shooting is carried out for other species including pigs, deer and goats across the entire KNP landscape where they are encountered. This is conducted by NPWS staff who are trained, experienced and annually tested under the NSW Government FAAST program, however the animal welfare outcomes of these operations have not been reported. In other jurisdictions, aerial shooting operations of large feral herbivores have been independently audited to determine wounding rates and estimated time to death (Hampton et al. 2014, 2015). Such auditing of animal welfare outcomes has the capacity to enhance public confidence in the application of wild horse control methods.

Passive trapping offers a means of removing relatively small numbers (anywhere from a single horse up to a maximum of 10–15 horses in a single trapping event) and can be employed in areas where mustering is not feasible. It should be noted that trapping as it is currently conducted in KNP is highly labour intensive, requiring at least two trained personnel to set, check and clear traps and transport horses from the trap sites. It can take up to six weeks from the initial set-up of trap-yard infrastructure, with calcium-molasses blocks or liquid molasses as lures, until horses become accustomed to and comfortable entering trap yards. Trap yards must be checked at least every 24 hours once set. Remote surveillance systems such as cameras accessible through phone networks are not an option in many areas within KNP because of lack of phone network coverage, therefore traps require physical checking. Some trap yards are monitored by game trail surveillance cameras to assist with determining numbers of horses visiting traps before they are set, as well as to deter trap-yard vandalism and interference. A total of 32 different trap-yard locations have been utilised in various locations across KNP (Figure 3). A total of 2957 horses were removed from the park from 2002–2014 via this method. Trapping within KNP is currently constrained to areas with vehicle access and trapped horses are loaded onto a stock trailer or truck and removed off-park. Consequently, trapping and live removal is not currently applicable across the full range of the horse distribution area within the park.

Trials of trapping at remote locations and then leading trapped horses out were conducted in 2002 utilising local horse riding group volunteers and NPWS staff. NSW RSPCA staff observed and monitored the trial. Trapped horses were subsequently roped and led short distances (only up to 500 m) utilising horse riders to where they could be loaded for transport. The trial was abandoned because of unacceptable safety risks to the staff and volunteers involved and because of stress and welfare concerns for the horses. Prohibitive injury and liability insurance costs to cover volunteers for the program were another factor that led to the technique being abandoned.

The current trapping and removal program is also constrained by the ability to rehome and domesticate captured horses or otherwise dispose of unwanted horses to slaughter. These are dependent on community demand for adopting or rehoming a horse or markets for horsemeat; factors beyond NPWS control and influence. In many instances the associated

costs of lairage (agistment, feed and watering of stock awaiting slaughter), fuel and transportation costs to abattoir or knackery are not economically viable. Only 518 (18%) of the 2957 horses removed via passive trapping thus far were rehomed or domesticated. The remaining 82% of horses were sent to a knackery or abattoir for slaughter.

A number of the trapping sites depicted in Figure 3 have been decommissioned due to their remote nature, necessitating trapped horses to be transported longer distances over rough tracks and trails resulting in concern from staff over reduced animal welfare outcomes for transported horses. Trapping and then humane killing in situ at the trap site is an approach that could be utilised anywhere within KNP. Traps can be established in remote locations by flying in trap-yard panels by helicopter. Limitations to this approach include the need to check trap yards every 24 hours when set, which can become cost prohibitive if this needs to be done via helicopter or if staff need to camp on site for the trapping period. The humaneness assessment panel identified that a SOP for the humane killing in situ of horses (using an appropriate noise-suppressed firearm) is needed to ensure both operator safety and best practice animal welfare outcomes for horses. Similar SOPs exist for the humane killing of livestock during disease outbreaks using facilities such as portable 'knocking boxes', races or appropriate screening arrangements. These factors would need to be incorporated into trap location and design.

Subsequent processing or disposal of horse carcasses at trapping sites is another challenge. If only small numbers of carcasses (<10) are present, then leaving them in situ to decompose could be viable. Research indicates that small numbers of carcasses do not pose an environmental or water contamination risk nor do they have any significant long-term impact as a food source for other pest species (Forsyth et al. 2014; Read & Wilson 2004). In summer, sambar deer carcasses (at least 150 kg, but rather smaller than horses) have been found to decompose rapidly, such that they become unpalatable, and unusable as a food source for carnivores within around 11 weeks (Forsyth et al. 2014). However, consideration does need to be given to the potential public reaction to the presence of decomposing horse carcasses. In more remote, less visited sections of the park, this may be acceptable. In higher visitation areas consideration would need to be given to flying out carcasses for subsequent disposal. Guidelines for disposal of horse carcasses would be helpful, perhaps modelled on those devised for domestic stock following bushfires (e.g. Tasmanian Government 2014).

Ground shooting by trained professional operators has the potential to be effective when applied to areas with low population densities or small isolated populations, as part of a coordinated and planned program with sustained management effort. Ground shooting is not an effective method for large-scale removal as only small numbers of horses can be shot from an individual mob at any one time, although efficacy may be increased through the use of noise-suppressed firearms. Ground shooting is currently used by suitably qualified and skilled staff when euthanasing injured individual animals in open free range situations across KNP.

Fertility control has the potential to prevent population growth if 30–40% of mares are treated. Long-term gradual population reduction is possible only if 60–80% of mares are treated. Fertility control is therefore only a viable option where horse densities are already low and the objective is to reduce or maintain the population at a low density. Even under these circumstances, there are challenges treating individual horses in an open wild landscape situation. Delivery of fertility control via darting requires the shooter to be a fixed distance (approximately 30–50 m) away from the target horse for the dart to be successfully injected. This is extremely difficult to achieve via helicopter and has not yet been successfully trialled either for PZP or GnRH vaccine. Delivery of these contraceptives through stalking and ground shooting using dart rifles has been achieved in both the US and UK, but only for herds at a much smaller scale (200–300 horses) that are within a relatively constrained or defined landscape (fencing or terrain barriers). Thus delivery of fertility control is currently only regarded to be feasible if it involves either mustering or passive trapping, treatment and

subsequent release. This could be used in areas where mustering is possible, once current densities have been reduced to the desired level by other control methods. Rangers could also deliver fertility control vaccines on an opportunistic basis if they were equipped with darting equipment, or it could be used selectively to treat horses that are unsuitable for domestication, although horses that are not desirable for this purpose may also be unsuitable for fertility control.

The currently available immunocontraceptive vaccine agents require that horses (mares) be re-treated at least every 2–4 years to limit their ability to conceive and bear young. Currently there is no single-dose agent that achieves permanent sterilisation of either male or female horses; however, research is currently being undertaken using phage peptides to target non-renewable germ cells within horses to achieve sterilisation. Permanent sterilisation of individual horses can currently only be achieved via invasive surgical procedures such as gelding for stallions or ovariectomy for mares, both requiring horses to undergo trapping, sedation and general anaesthesia. Contraceptive treatment can have unexpected secondary or side-effects, including physiological and behavioural impacts (reviewed in Gray & Cameron 2010), which may include ecological feedbacks (Ransom et al. 2014b) and negative animal welfare outcomes (Hampton et al. 2015). This is currently an under-researched area of study, but secondary effects reported in horses include both increasing (GnRH formulation: Ransom et al. 2014a) and decreasing (PZP formulation: Nuñez et al. 2009) band stability, increasing stallion–mare reproductive interactions (PZP: Ransom et al. 2010), and extending reproductive cycling beyond the breeding season (PZP: Nuñez et al. 2010).

Under present circumstances, fertility control is not a cost-effective method of reducing horse numbers and impacts across KNP. Research may develop more improved broad-scale application techniques and these should be reviewed as they become available.

Fencing can be an effective means of excluding pest animals such as horses from small-scale specific areas (Dickman 2012). Consideration was also given to the potential for fencing along the road barriers defining Region 2, to reduce the potential for horses to move into this area from Regions 1 and 3, as well as reduce horse road traffic interactions and risks. The workshop found that roadside fencing should at least be considered as a potential exclusion method; however, fencing to limit the expansion of horses into Central KNP and to reduce the incidence of road traffic accidents would also have implications for the movement of other wildlife, would require continuous maintenance, and would likely cost around $4 million (this estimate does not account for environmental planning and approval works, gates, grids, stiles, creek and river crossing arrangements that would all need to be established to ensure continued public access). As an approach, it is not without complications. Any proposal for the construction of such a major barrier fence line would therefore need to compare it to other options and carefully consider whether it would be effective in containing wild horses, as well as impacts on other wildlife movement, public and management access, safety, and park values.

Roping (brumby running) is considered by the ITRG to be a cultural pursuit, not an effective or humane method of reducing horse densities, since only small numbers of horses can be removed at any one time and the risk of injury and distress is high (see Section 4, *If horses have to be removed, what methods are currently or potentially available?*; and previous comments on the trapping and removal of horses via roping and leading).

5.7.3 Overall findings on control methods in a management context

- Aerial mustering and aerial shooting can be effective for rapidly removing large numbers of horses, but the relative humaneness and effectiveness of both these methods depends on the terrain, vegetation structure, and scale at which they are conducted.
- Best practice aerial shooting requires targeting small groups of horses in relatively flat, open areas with minimal high-canopied vegetation.

- Best practice mustering requires moving horses over relatively short distances within their home range into yards located in a flat and open central area. Road access is also required unless horses are humanely killed in situ.
- Passive trapping and ground shooting can be effective in removing small numbers of horses over time. These methods are best applied to areas with low population densities or small isolated populations, as part of a sustained management effort in conjunction with large-scale removal methods.
- Best practice ground shooting can be applied in most areas where horses are present and ground access is possible.
- Best practice passive trapping can be applied in most areas where horses are present and there is sufficient clear space to deliver and set up traps. Road access is required unless horses are humanely killed in situ.
- Fertility control is only a viable option where horse densities are already low and the objective is to gradually reduce or maintain the population at a low density. Its broad-scale effectiveness in the context of KNP (or in any other wild population) is yet to be determined.
- Delivery of fertility control currently requires either mustering or ground-based darting; the same limitations apply for these methods in terms of achieving best practice as are outlined earlier.
- Fencing can be an effective means of excluding horses from small-scale specific areas.
- Best practice for all of the above methods requires highly competent trained operators and adherence to SOPs or their equivalent.
- Independent animal welfare audits have the capacity to measure outcomes and enhance public confidence in the application of wild horse control methods.

5.8 Selection of control options appropriate for each environment type

The following selection of control options is based on the humaneness assessment model applied to horses in KNP (see Section 4, *If horses have to be removed, what methods are currently or potentially available?*). Three groups of control option zones were identified, delineated by vegetation structure, where the control methods listed could be applied in accordance with best practice, without a reduction in humaneness (see Figure 3):

Control Option Zone Type 1 – covering areas of grassland, herbfield, shrubland, bogs and fens. The following control methods could be considered for application in this zone: mustering, aerial shooting, ground shooting and trapping (for removal or in situ humane killing). This environment type would also be suitable for a fertility trial.

Control Option Zone Type 2 – covering areas of open woodland. This type is only suitable for ground shooting and trapping (for removal or in situ humane killing). Fertility control through ground darting could potentially be used in this zone but only once impact reduction targets had been reached.

Control Option Zone Type 3 – covering areas of open and closed forest. This type is suitable for ground shooting and trapping and humane killing in situ. Trapping for removal may also be possible in locations where there is existing road and trail access.

The following section discusses the feasibility of application of control in specific areas within the northern, central and southern regions of the park, using these three vegetation structure categories. The final choice of control methods in each of these areas will be linked to the presence of horses and the management objectives for each area (i.e. asset protection, prevention of incursion, containment and/or eradication).

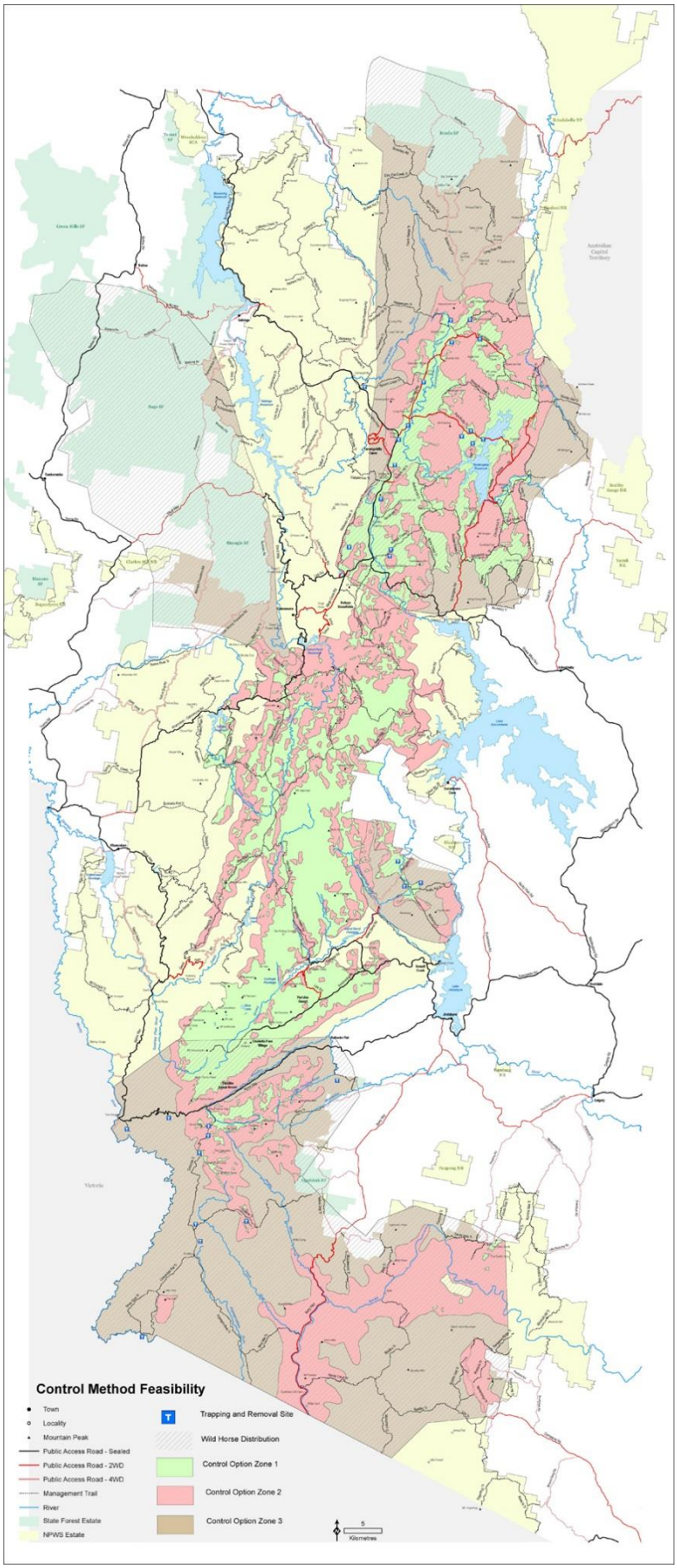

Figure 3: Map indicating where various control options are feasible

5.8.1 Northern KNP management region

Western forested country

Much of the north-west and northern sections of this region, comprising the Bogong Peaks, Goobarragandra, Bramina and Bimberi Wilderness areas, are tall open forest, tending to have almost continuous canopy in some areas. Coupled with the steep terrain, these features would rule out the opportunity for best practice aerial mustering or aerial shooting. The density of horses here is much lower than in the south-east corner of this region; many areas are regarded as 'horse free' or very low density and marginal habitat. Equally though, it is very difficult to manage horses in this area due to the nature of the vegetation and terrain and limited vehicular access.

Ground shooting is a possible means to remove small numbers of horses here. However, the most efficient means of reducing densities is likely to be to draw horses from the forest out into the adjoining plains and open grassland areas by reducing densities and thus competition for resources and territory in these areas.

Passive trapping with portable traps flown into small clearings and humane killing via shooting on site could be used in remote areas where there is no road access.

South-eastern grassland country – Long Plain, Tantagara, Nungar, Currango and Cooleman Plains

The highest densities of horses in KNP occur in the grassy plains in the south-east of Northern KNP. There is reasonable vehicle access to the edges of the plains on established management trails, although much of the access is limited to 4WD vehicles with a stock trailer used for transporting horses (see current trapping and removal sites indicated in Figure 3).

Mustering would be possible in this area in locations with suitable road access to allow transport of gathered horses. Experience from the Kaiwanawa Mountains, NZ, shows that mustering using helicopters alone with no or minimal ground support (person on foot or horseback) is possible if suitable terrain and placement of yards and wing fences can be achieved (e.g. Cameron et al. 2001). Both aerial (helicopter) and ground mustering (or a combination of both) would be feasible provided people on the ground (on horseback or using all-terrain vehicles) stayed close to the yards (to help funnel horses in) and avoided causing environmental damage to the surrounding area. Best practice **aerial shooting** would also be possible in this area.

Passive trapping is currently used with 20 fixed trap sites in this area with 2207 horses removed since 2006 using this method (a maximum of 633 horses were trapped and removed in a single trapping season). Between two and 10 trap sites are generally set at any one time. All traps are checked and cleared within 24 hours of setting and horses loaded and trucked out to a holding area at the NPWS Blowering Depot holding facility, 1.5 hours from the furthest trap site, or directly to a contractor/rehomer. Most trapping occurs in winter as horses are more attracted to the molasses licks at this time and there is less public access to the area, reducing interference with the traps. Trapping at this time of year also avoids capturing heavily pregnant mares and young foals at foot, or holding horses during the summer heat. Trap locations are currently sited to avoid cold air drainage sink areas in the plains area, which are not suitable for traps or holding yards for mustering in winter as they would be too cold at night (horses would normally move out of these areas as the temperature drops to shelter in adjoining forested areas on ridgelines).

Ground shooting could be used anywhere in this area.

North-west of the Cabramurra – Khancoban and Link Roads – World's End

The area around World's End, west of Cabramurra, should be monitored for movement of wild horses from the Bago-Maragle State Forest (crossing the Khancoban–Cabramurra Road) into Central KNP. There are currently two passive trapping sites in this area; only small numbers of horses are currently being trapped. Ground shooting could also be used here.

Specific management units

This Northern KNP management region also contains the Yarrangobilly (18,122 ha) and Cooleman Plain (10,500 ha) management units. These two specific areas, along with the Main Range management unit in Central KNP, were identified under the KNP 2006 Plan of Management as areas of exceptional natural and cultural significance. Cooleman Plain includes grassland where Option Type 1 control may be relevant. Subsequently they were identified in the 2008 KNP Wild Horse Management Plan as areas where the aim is to remove and exclude wild horse populations. To date, under the constraints of the current management program, this has not been achieved.

5.8.2 Central KNP management region

The majority of this region is regarded as horse-free except for an established population at Snowy Plain. There is evidence that horses from Snowy Plain are spreading further west and north-west into the horse-free areas of Jagungal Wilderness. There are now regular seasonal incursions of small numbers of horses from Southern KNP in Dead Horse Gap and Leatherbarrel Creek areas to the south onto the true alpine area of the park of the Ramshead Range and Kosciuszko Plateau. Horses are also moving from the north of the Snowy Mountains Highway, out of Northern KNP south into areas including Mount Selwyn ski resort, Four Mile Hill and towards Mount Tabletop.

Snowy Plain

The group considered that the Snowy Plain/Botherum Plain area to the south-east provided the best potential for **mustering** in this region. To achieve effective results this would require negotiation with adjoining landholders to gain permission to muster from neighbouring properties and facilitate cross-tenure management over the longer term. Best practice **aerial shooting** would also be possible in this area.

Passive trapping has been in place in this area for several years: a total of 111 horses have been removed from three trap sites since 2012, however there is little potential to remove greater numbers unless trapping is combined with other methods. Removal of captured horses from the Snowy Plains area necessitates travelling on a rough dirt road via a stock trailer (towed by a 4WD vehicle) that can carry a maximum of eight horses at a time. Horses are taken directly to a holding area in the trailer or can be transferred to a larger vehicle once across the Eucumbene River.

Ground shooting could be applied anywhere in this area.

Main Range – Thredbo/Alpine Way

The Main Range management unit (20,800 ha), which includes the southern boundary of Central KNP around Thredbo/Dead Horse Gap, was identified under the KNP 2006 Plan of Management as a key area for wild horse management due its environmental sensitivity and unique natural heritage significance. While there are currently relatively few wild horses here, small mobs of approximately 6–10 horses are now annually pushing up into this area during spring and summer. Their removal would significantly reduce the potential for ongoing incursions of horses from the south establishing new populations of wild horses in this region. There is minimal potential for mustering in this area due to the lack of road access. However, the group noted that horses have been seen in the relatively flat and open high alpine plateau above the tree line, such as the Ramshead Range or headwaters of the Swampy Plains River and Wilkinsons Valley. In these areas, the group considered that best practice aerial shooting could be employed effectively to target small numbers of horses at a time.

Passive trapping could also be employed but the lack of access roads means this would need to employ portable traps flown in and established by helicopter. Trapped horses would require humane killing on site with carcases left in situ or flown out via helicopter.

Other areas

Passive trapping with humane killing on site could be used in other remote areas where horse density is currently low, but this would be limited in terms of the numbers of horses entering traps.

The area west of Central KNP, between the Murray River and Alpine Way, is currently relatively horse free and is likely to remain so if there is management of adjacent areas. A planned and targeted **ground shooting** program of individual animals or small mobs could be used here to reduce the risk of horse incursions into Central KNP.

5.8.3 Southern KNP management region

South of the Alpine Way

Passive trapping is currently employed in the area south of the Alpine Way. There are three trap sites around Dead Horse Gap and Bobs Ridge and two more to the west at The Wattles and Riley's Flat. Another trap site on the eastern edge of the park near Little Thredbo River has not been used for the past two years due to trap interference and vandalism. Trapping and removal was also conducted in the core of this region at the Tin Mines, Tin Mine Creek, Bills Garden and The Lookout for a number of years. This was abandoned after concerns with regard to difficult access to service traps and welfare concern for horses being subject to long transportation distances over rough 4WD trails. A total of 486 horses have been removed from this southern region area since 2006. The intention of focusing trapping in this area was to reduce the movement of wild horses north across the Alpine Way and into Central KNP onto the Main Range management unit.

Mustering would be possible in some of this area where horses congregate, such as the headwaters of the Thredbo River or Big Boggy and where there is suitable road access to transport mustered horses out. Alternatively, horses could be mustered to remote yard situations and then humanely killed on site.

Ground shooting could be used here.

Aerial shooting targeting small groups of horses could be considered in some open woodland areas here such as sub-alpine areas and frost hollow valleys around the upper Thredbo River and upper Ingeegoodbee River catchments, where the terrain is relatively flat and horses are clear of cover. Aerial shooting of pigs and deer is currently conducted in these areas and horses are regularly encountered during these operations.

Pilot area

This area is defined by the western boundary of the park, Tin Mine Trail in the north, Barry Way in the east and the Victorian border in the south.

Across the Victorian border in the Cowombat Flat area a combination of trapping and licensed brumby roping programs by Parks Victoria removes around 50 horses per year. Brumby roping (running) also occurs here with the permission of the Victorian Government (Parks Victoria 2013). Illegal roping also occurs on the NSW side of the border around Ingeegoodbee River. Estimates suggest this may remove between 30 and 50 horses a year.

There is very little open grassland in this area so aerial shooting or mustering are not suitable options.

Passive trapping with portable traps and humane killing via shooting on site could be used in remote areas where there is no road access.

Byadbo – east of Barry Way

Because of its rain shadow woodland nature, this area has a relatively low open canopy with limited understory. Pigs, deer and goats are currently managed here by aerial shooting in combination with ground shooting, trapping and baiting programs. Information on the animal

welfare outcomes of these shooting operations would assist in determining whether best practice aerial shooting of wild horses is achievable, for example, along the river lines where the country is open and horses would be channelled along the valley.

Mustering for removal would be extremely difficult here as there is no road access. Similarly, passive trapping would require portable traps to be flown in and on-site humane killing, but because there is limited access to water, during drought periods more horses could be attracted to traps using water sources.

There is a location in the far east of this area, around the Merambego and Byadbo Gap Trail, that is a potential site for a **fertility control trial** as it is a relatively isolated population of wild horses. However, the inaccessibility of this location may preclude this (researchers conducting the trial would need regular access to conduct monthly mark and recapture, and obtain faecal samples, etc.). Such a trial would also need a control site with similar density.

Any management in this area of the park would need to consider management on adjoining private land and may require the establishment of extensive fencing to contain the population.

5.9 Fate of captured horses

The overall management of wild horses in KNP should be informed by the objectives established for the particular management region and the need to reduce their impacts, rather than limited by the capacity to move captured horses in to a finite market for rehoming or other uses. However, where mustering or trapping is undertaken it should be with the intention of placing as many horses as possible with owners for domestication. Not every horse trapped or mustered, though, is able to be domesticated and therefore it will continue to be necessary to humanely kill a proportion of captured horses (as is currently the case). In order to increase demand for captured horses, efforts should be made to publicise the availability of wild horses with support from the community and brumby groups. In order to ensure horses are trained, handled and treated well, groups applying to take captured wild horses would need to demonstrate their capacity to meet minimum standards and undertake to meet these standards through contractual arrangements before horses are supplied.

Rehoming or domestication strategies would work best if all horses removed from the park were transferred to a holding area to be drafted and spelled and to maximise the chances of rehoming as many suitable horses as possible. For those horses that are unsuitable or cannot be rehomed for domestication, it is clear from the humaneness assessment work that humane killing in situ via shooting on site by a trained professional was likely to deliver a more humane outcome than long-distance transport for abattoir slaughter, due to the cumulative animal welfare impacts of each of the stages involved.

5.10 What is the overall management objective?

The ITRG has concluded that eradication of horses from KNP is not achievable. That being the case, we recognise that a management plan is required that allows for the presence of horses. Any management objective needs to recognise the following:

- Environmental assets in parts of the park need to be protected from the impacts of horses.
- The agreed heritage value of the horses also needs to be appropriately acknowledged.
- A broad range of community expectations needs to be observed.
- Clearly defined management regions and zones are required to facilitate this coexistence.
- Management actions in the different regions and zones need to be prioritised based on desired outcomes and associated resource requirements.

- Variable densities of horses will be required throughout these regions and zones as defined by ongoing survey methodology and acceptable levels of impact.
- Where management of horses is required, humane options for their removal are essential (ruling out certain methods).
- Where management is imposed, it has to be in the most efficacious manner in the short term, so that in the long term, removal of large numbers of horses is no longer required.

A two-step management objective, utilising adaptive management principles, would therefore become:

- short term (5 years) – removal of horses from key zones for the purpose of asset protection, and moving towards acceptable numbers across the park, and
- long term (20 years) – strictly managed presence of horses in designated parts of the park, unacceptable environmental impacts minimised, and the need to remove large numbers of horses minimised.

A useful model with which to start drawing up an adaptive management approach for wild horses is within the NSW Office of Environment and Heritage's *Adaptive Management Position Statement* (OEH 2015). This document recommends beginning by devising a process model, which aims to describe 'how management actions are expected to achieve the objectives – by modifying the threats or processes that are driving the system' (OEH 2015). OEH could also consider developing contingency plans for horse control in response to fire, drought, disease and climate change, in order that it conform to the *NSW Biosecurity Strategy 2013–2021* requirement that management plans be able to adapt to changing environmental circumstances. In doing so, the *NSW Biosecurity Strategy 2013–2021* (NSW Government 2013) and the Animal Health Australia AUSVETPLAN *Wild Animal Response Strategy* (Animal Health Australia 2011) may be used for guidance. In the event that a consultative group is formed to assist in implementing the Wild Horse Management Plan, it is suggested that scientific membership be sought for this group.

6. What are the priorities for research to inform management of wild horses in KNP?

Research is needed to help inform management decisions in KNP. A computer model for horse populations based on known or to be determined demographics would allow managers to explore the consequences of their decisions. Such a model could start simply but become more sophisticated as knowledge of horses in KNP grows. Large-scale studies of horse impacts on the diverse environments of KNP would assist in prioritising and partitioning management zones. Research on control methods, including humane killing and fertility control following trapping, will increase the options available for managers.

6.1 Overview of approach taken

The ITRG concludes that there are significant knowledge gaps in our understanding of horses in KNP. This section suggests research topics that the ITRG concludes would have the biggest positive impact on management of horses in KNP, in the shortest time. It should be noted, however, that the ITRG is not advocating that no management be undertaken until more research is done. There is certainly sufficient indication that the impacts of horses in the park require management action now. As the precautionary principle outlined in the *Protection of the Environment Administration Act 1991* states:

> *If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reasoning for postponing measures to prevent environmental degradation. In the application of the principle… decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and (ii) an assessment of risk-weighted consequence of various options.*

Furthermore, the needs of research or experimental design must not be allowed to compromise the requirements of sound management of wild horses in KNP. Instead, research should be focused on informing the adaptive management approach recommended above. The ITRG considers that a research hub would help focus horse research efforts and avoid any duplication or unnecessary research. OEH could start the process with a workshop bringing together key research players and stakeholders.

6.2 Stakeholder suggestions for further research

The following is a brief summary of ideas from stakeholders for further research, submitted to the ITRG as part of the consultative process. Questions stakeholders would like to see addressed include:

1. What is the wild horses' impacts on wetlands in the KNP? (submission by Fenner School)
2. How many horses are there and how often are they accessing the higher alpine areas of the KNP? (an individual submission)
3. What shorter-term and longer-term control options can be used to reduce wild horse numbers in the KNP? (Canberra Bushwalking Club)
4. Could community partnerships be used to monitor the environmental impact of wild horses? (Canberra Bushwalking Club)
5. Evaluation of the efficacy, safety and humaneness of 'brumby running' (issue raised by a number of submissions)
6. Can aerial mustering be done humanely and safely? (Southern Ranges Region Advisory Committee)
7. What is the genetic value of the brumbies in the KNP? (Southern Ranges Region Advisory Committee, Victorian Brumby Association, and an individual submission)
8. Could a limited number of horses be maintained and controlled in certain areas of the KNP and eliminated from others? (Southern Ranges Region Advisory Committee)
9. Do the faeces of wild horses in the KNP pose a health risk to people walking and camping? (an individual submission)
10. Can fertility control be applied within the horse population of the KNP and would it be likely to be effective? (Australian Brumby Alliance, Victorian Brumby Association, Brumby Working Group and others)
11. How do current control methods rate in terms of:
    - the humaneness of the method
    - the safety of those involved
    - effectiveness
    - logistical requirements, and
    - environmental impacts?

    (an individual submission)
12. What are the pre- and post-settlement social heritage values and how do these affect the approaches available to controlling wild horses in the KNP? (Australian Brumby Alliance)

13. Is there a sustainable number of wild horses that could be maintained within the KNP? (an individual submission)
14. Can fencing be safely used to limit the movement of horses to certain areas of the KNP? (an individual submission)
15. Is there a methodology that can be used to regularly assess horse numbers in the KNP and can provide confidence in the real number of horses that are in the KNP? (Hunter Valley Brumby Association)
16. Are there benefits to the local environment from wild horses in the KNP and how would these be quantified? (Snowy Mountains Horse Riders Association)
17. What would be the costs, benefits and challenges in implementing the StockWHIP program and would there be a significant impact on horse numbers in the KNP? (StockWHIP).

Some of these ideas are, to a varying extent, addressed in the ITRG report (e.g. see Section 4.2, *Assessing the humaneness of different control methods*). The ITRG has also attempted to integrate them, where appropriate, into its prioritised list of research needs (see following sections).

6.3 Research priorities identified by the ITRG

The priorities identified below have emerged from our immersion, as the ITRG, in the issue of wild horses in KNP, and our consideration of the ideas suggested by stakeholders above, collectively filtered through our experience as scientists familiar with the targeting of research at applied outcomes.

6.3.1 Research – horse ecology, especially demography, behaviour, distribution and abundance[1]

A high priority here is to develop a population model for horses in KNP. An initial simple modelling exercise, as discussed in response to the question posed in Section 2.3, *What impact would different levels of removal have on horse numbers?*, would be a good way to start, and help to identify data gaps. An initial demographic model could be constructed from the literature, and using data from animals that are mustered, if mustering occurs. A more sophisticated model, developed over time, would ideally be spatially explicit and agent-based, to incorporate the range of individual horse behaviours. It would incorporate findings from demographic, behavioural and other studies as they become available, allowing different management options to be tested in a sophisticated way. For example, the feasibility and consequences of fertility control, as suggested below, could be explored through a modelling exercise.

Surprisingly little is known about the ecology of horses in KNP. Some very useful information would come from funding PhD projects on behavioural ecology, demography, movement ecology, habitat preference, and abundance. As one of the key aims of management is likely to be to prevent incursions into new areas and reduce densities in many currently populated areas, research is needed on re-invasion rates, frequency of control, local movement behaviour of horses in response to control and no control. All these findings would be best directed at building the horse population model to inform management decisions.

6.3.2 Research – impact of wild horses

As a matter of priority, comprehensive regional-scale studies on key environmental impact characteristics across different alpine and sub-alpine landscapes, building on the recent

[1] See also our recommendation in the Executive Summary on re-thinking survey approaches.

impact report (Robertson et al. 2015), will help understanding of how impacts vary with habitat type. Studies of more efficient ways of measuring and equating numbers, density and damage should be conducted, and the relationship between density and damage characterised as far as possible.

6.3.3 Research – methods of control for wild horses

As a top priority, a standard operating procedure needs to be developed for best practice humane killing in situ of wild horses captured through passive trapping or mustering. Information on the cost per horse of current control methods and costings for all control methods is needed to match humaneness and efficacy assessments with cost-effectiveness.

Fertility control is much discussed among stakeholders in Australia and overseas, and may be a useful tool for horses, especially if numbers are low and/or localised. It is not a silver bullet, however, and the high expectations of such research are often not realised. It should be explored, but a prerequisite for conducting fertility control research is a thorough research plan, plus costings, starting with a pilot study. The ITRG considers that this should not be just another captive animal efficacy experiment conducted in isolation, or on a localised population, but one examining the logistics of delivery mechanisms and the effect on populations in the field. It is important to consider any long-term effects of fertility control, e.g. prolonged life span and related population dynamics (see Gray & Cameron 2010 for a review of potential side-effects of contraception, especially in wild vertebrates). The applicability of fertility control also needs to be modelled on data from free-living animals, not captive colonies (see outline of modelling needs above), as efficacy is typically lower in free-living populations (e.g. Gray et al. 2010). The application and outcomes of fertility control could be compared with other management techniques (see McLeod & Saunders 2014 for an example). A watching brief should also be maintained on longer-term fertility control research (e.g. that conducted at the University of Newcastle).

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Appendix A: Independent Technical Reference Group terms of reference

The role of the Kosciuszko National Park Wild Horse Management Plan Independent Technical Reference Group (ITRG) is to provide independent and rigorous scientific and technical advice to NSW National Parks and Wildlife Service on the management of wild horses within Kosciuszko National Park.

Background

The NSW Minister for the Environment has asked NSW NPWS to conduct a review of the Kosciuszko National Park Wild Horse Management Plan which will look at the wild horse impacts on the reserve's environment and consider all best practice control methods currently available including ground and aerial shooting.

The issue of wild horse management within KNP and at a state wide, national and international level is highly contentious and emotive. It is also a challenging community relations issue for public land and conservation reserve managers. There is a diverse and deeply polarized range of views in the community about if and how wild horses in the Park should be managed.

The 2003 and 2008 KNP Wild Horse Management Plans incorporated extensive community consultation processes and considered ten different methods of controlling wild horse populations. These plans only endorsed two control methods; trapping and removal, and mustering using low stress techniques. These methods were approved as being operationally viable and acceptable to the broader community and reflecting public opinion in regard to applying lethal methods of control for wild horse management.

Kosciuszko National Park is the largest national park in NSW and one of the largest conservation reserves in Australia. The park was declared in 1944 and is now a UNESCO Biosphere Reserve. It contains continental Australia's highest mountains as well as a great variety of outstanding scenery, natural features and native plant and animal communities.

The NSW National Parks and Wildlife Service (NPWS), a division of the NSW Office of Environment and Heritage (OEH), has a legal responsibility to protect native habitats, native fauna and flora and geological features within its reserves. That responsibility also includes the minimisation of impacts of introduced species, including wild horses on those park values.

A KNP Horse Management Plan (2008) was developed following on from the Horse Management Plan for the Alpine Area of Kosciuszko National Park (2003) and Kosciuszko National Park Plan of Management (2006) and associated community consultation, engagement and planning processes.

These planning documents outline the current guiding principles, key directions and objectives for horse management within the Park and the operational program of wild horse management that has been implemented in the park for the past 10 years. Those current objectives and principles include:

- to exclude horses from
    - the Main Range Management Unit;
    - the Yarrangobilly Management Unit;
    - the Cooleman Plain Management Unit;
    - areas such as highways where there is a safety risk;
    - areas of the Park where horses have not been or have only recently been recorded (e.g. Jagungal);
    - areas of the Park adjoining other Australian Alps national parks and reserves; and
    - feeder areas for all of these parts of the park.

- to reduce horse numbers in other specific areas to reduce the risk they pose. These areas would be where horses have an impact on public safety, the environment or on the cultural heritage of the Park
- to make sure that all horses are treated humanely throughout the removal process and their removal complies with current Codes of Practice
- to work with neighbours and the community in NSW, the ACT and Victoria to ensure that an integrated and cooperative approach is used to reduce the impact of horses on the Park;
- to make sure that the community is consulted about how we are going to remove the horses;
- to ensure that the removal process does not harm the natural and cultural values of the Park;
- to continue to research and monitor horse populations and the impact they have on the environment, and use this information to improve horse management practices;
- to monitor advances in horse control methods, such as fertility control, to ensure the most effective methods are being utilised in the program.

Scope of the Independent Technical Reference Group

The Group will provide rigorous scientific and technical advice to NSW NPWS on the management of wild horse populations within Kosciuszko National park particularly in regard to population assessment, the monitoring of their impacts on Park values and methods of control. The KNP Wild Horse Plan ITRG will where able :-

- review and provide advice on the current distribution, abundance and density of the horse populations within the park and advise on population modelling under various potential management regimes.
- review and report on the relevant scientific literature and methodologies for the assessment of impacts of wild horse populations on the natural and cultural values within Kosciuszko National Park.
- review and provide advice on the existing assessment of the nature and extent of the impacts of wild horse populations on the natural and cultural values of the park.
- provide advice and assist in evaluating the need for control of wild horse populations where populations are identified as having an impact on natural and/or cultural values of the park.
- provide advice and assist in identifying and reviewing the current objectives for the management of wild horses across the park landscape, including setting targets for population numbers that will provide for the protection of the natural and cultural values of the park.
- review and provide scientific and technical advice on the current and proposed control methods for wild horse populations within Kosciuszko National Park.
- review and provide advice on the most appropriate control techniques currently available for horse population management in regard to the techniques humaneness and animal welfare considerations.

Composition of the Independent Technical Reference Group

The Reference Group will have an independent Chair and a Deputy Chair. The Deputy Chair will assist the Chair and fulfil the Chair role for any meetings the Chair is not able to attend. The Executive Director of the Scientific Division, Office of Environment and Heritage, NSW or their appointee will also be represented on the group.

The Reference Group will comprise scientists and individuals with expertise in one or more of the following fields:

- Invasive animal and vertebrate pest management (including the assessment of invasive species and their impact on environmental, cultural, social and economic values)
- Horse ecology (including demography, reproduction and behaviour) and/or horse population control techniques.
- Animal welfare and veterinary science.
- Biology and ecology of the flora and fauna of the Australian Alps / Kosciuszko National Park and associated alpine, sub alpine and montane ecosystems;
- Soil erosion and soil processes

If it is determined that additional scientific expertise is required, additional scientific appointments may be made.

The Reference Group will be appointed by the NPWS Branch Director (Metro and Mountains) – Tom Bagnat. Group members will be appointed for two years, with the option to reappoint.

Reporting

The Project Control Group headed by Tom Bagnat will be responsible for the review of the Kosciuszko National Park Wild Horse Management Plan. They will seek technical and scientific advice from the ITRG and provide direction and feedback to the ITRG.

The ITRG will report through the Chair and Deputy Chair to the Project Control Group who will inform the NPWS/OEH Executive. The ITRG will produce minutes of each meeting through the Executive Officer with secretarial support supplied by NPWS and the Senior Project Officer

A final report will be prepared by the Reference Group outlining its findings and summarising the advice provided to the Project Control Group.

Meetings

NPWS/OEH will be responsible for convening the Reference Group for a particular meeting through the Deputy Chair with any assistance from the KNP Wild Horse Management Plan Review Senior Project Officer as required

The number of meetings will be kept to a minimum and are likely to number 2-3 meetings in a 12 month period. The Reference Group is expected to operate for a period of approximately 2 years, until the end of 2015. This may vary according to operational requirements and Government / departmental preferences.

The Group will meet approximately three times per a year, face to face, with the venue being in a location being most suitable or central to the majority of members, and one meeting involving a field visit and opportunities for site inspection. The costs of these meetings including travel and subsistence will be borne by the host agency NPWS/OEH.

Committee and out of session business will also be conducted by electronic conferencing where necessary and feasible. Meetings will be conducted to an agreed agenda. Out of session review of documents, papers and strategies will be required in preparation for meetings.

Group Running Costs, Group Member sitting fee and Group Member expenses.

NSW NPWS/OEH will be responsible for:

- Supplying an Executive Officer / Secretarial support to record meeting minutes and actions;
- The costs of meeting facilities and catering for that meeting or field visit;
- Payment of the appropriate sitting fee (where required) to each group member;
- Reimbursement to Group members of expenses for travel, accommodation and subsistence incurred in attending meetings or field inspections.

Members will maintain a log of costs incurred in serving on the Reference Group and submit to NPWS/OEH through the Executive Officer for reimbursement of expenses and payment of professional and sitting fees. NPWS/OEH will supply a form to capture relevant expenses.

Appendix B: Stakeholder submissions to the ITRG on horses in KNP

Overview

Stakeholders were invited to submit research, information or evidence to the ITRG on:

- wild horse numbers and distribution across the park
- wild horse impact on the park's values
- wild horse population control methods, and
- wild horse population management objectives for the park.

The ITRG received 32 submissions from individuals or stakeholder groups. In addition, the ITRG spent a day receiving oral presentations from stakeholders on 26 March 2015. In surveying the submissions, it is clear that stakeholders broadly fall into five groups, aligned around their attitude to horses and their control in KNP. Firstly, there are those who support the presence of horses in KNP and believe no form of control is acceptable (Group A). Next are stakeholders who support horses but accept the need for some management and control of populations in KNP (Group B). Then there are stakeholders who, while regarding wild horses as not a natural feature of the park, did not explicitly see eradication of horses as a goal, and talked instead of management of horses as an acceptable solution (Group C). Next, at the opposite extreme from Group A, are those who are against the presence of horses in KNP, and who believe they should be completely eradicated (Group D). Lastly, there were four inputs – termed here 'miscellaneous' – where the stakeholder group either did not make full submissions because they felt they lacked the capacity or resources to provide research, information or evidence to ITRG, or the submission could not be readily categorised in terms of a position on horses in KNP.

Group A – supportive of horses, no management necessary

Only one submission, from the Snowy Brumby Support Group, which indicated that it had a membership of about 1000, fell into this category. The Snowy Brumby Support Group believed that there were only significant benefits to be gained from the presence of brumbies in the KNP. The group wrote in support of horses as now being a natural part of the KNP ecosystem, arguing that horses were merely replacing lost marsupial megafauna that performed a similar role to horses in the ecosystem, removing groundcover, reducing the intensity of fire, and so on:

> *The ecological evidence to support the retention of big animal activity in the Australian ecology is very compelling. Internationally big plant eating animals enhance sustainability of biodiversity, water catchment values, fire risk management and tourist attraction to mention just a few positives chosen to be ignored by the insular anti grazing, anti-burning lobby apparently harbouring a deep seated fear of sharing the landscape with bigger animals than they are.*

They advanced the proposition that the absence of large grazing mammals results in suppression of native plant biodiversity through dominance by a few species and in addition the build-up of fuel load that intensifies fire:

> *Locking up land to mulch and bury biodiversity across the region in metres deep of flammable refuse is unsustainable long term in a flammable dry climate.*

In addition, they argued that horses improve water quality and quantity, through fire suppression:

> *Brumbies are now the last bastion of what has been successful water catchment management for millions of years. Greed, profit and doing nothing now drive what does not occur in the high country to secure the nations assets.*

They also suggest that there is an anti-grazing lobby actively working against the interests of wild horses and cattle in KNP:

> *The few grazed green areas provided by cattle Brumbies travelling or leased have to be removed as a matter of haste by the anti-grazing lobby because these areas were naturally made fire safe and what bogs and biodiversity remains in these areas.*

Suggestions for control and management

Because this group believes in the benefits of horses to KNP they did not support management of wild horses as an option and had no suggestions on control and management. In oral presentation, the representative of this group argued that humans are the problem in KNP, e.g. 4WDs, that more horse were needed in KNP, not fewer, and that they should not be excluded from any part of the park. Indeed, the representative, when asked, 'Are there any areas of the park from which you think brumbies should be excluded?', answered '*Not really – perhaps the bar at Thredbo!*'

Group B – supportive of horses, but accepting some management is necessary

We received submissions from six individuals or stakeholder groups in this category, basically arguing that horses do have a place in KNP, but that they need management, with the possibility of exclusion from some sensitive parts of the park. These stakeholders included the Hunter Valley Brumby Association, the Victorian Brumby Association, the Australian Brumby Alliance, the Brumby Working Group, and the Snowy Mountains Horse Riders Association.

These stakeholders support the presence of wild horses in KNP. For example, the Victorian Brumby Association wrote:

> *The VBA strongly advocates for the continued existence of wild Brumbies in the ANP and surrounding State Forest (SF). Having seen firsthand the health of environments where Brumbies numbers are low to moderate, it is our belief that Brumbies can co-exist with the natural values of the ANP. The ANP is an Australian and International icon. Australia – the country whose folklore is full of tales of our mountain Brumbies, the country that immortalised the wild horse in the opening ceremony of the Olympic games in 2000. The country that was raised on the tales of Elyne Mitchell and the Man from Snowy River. The country of people who are passionate about our beautiful landscape and our rich links with that landscape. Our country was explored, settled and supplied by the forebears of our Brumbies and their links with our culture and our national identity are deep and strong.*

The Snowy Mountains Horse Riders Association wrote passionately of the long cultural associations of settlers, horses and the KNP region:

> *Our group is predominantly made up of descendants of the original pioneers and settlers of the Snowy River side of the Mountains being the Jindabyne Dalgety Bombala Delegate, Adaminaby to Cooma and Monaro localities.*
>
> *Much of our rural local community that had attachments to the mountains has felt a lot of resentment and still do. The end of the grazing era, the flooding of our towns and our history for the Snowy Scheme and then 30 years ago we were then prohibited to even ride our horses in our traditional areas of the mountains as our ancestors did, these events changed our lives. The last kick in the stomach is to have our brumbies removed hence there will be nothing left to even demonstrate our history ever existed.*
>
> *Our history has been undervalued as a major part of the heritage. Very little is known about our families' beginnings in the mountains. The small amount of literature that the park use is based on only a few. Certainly since the grazing era there has been little done to bridge those gaps -and more so- fill the gap. Many of the original locals*

> *feel disenfranchised and even ostracised at times when it comes to the knowledge and heritage of the Snowy Mountains since white settlement. The management of brumbies has been a huge part of that heritage.*

The ITRG hopes that the Context report (Context 2015), which recognises the heritage value of horses in the region, has gone some way in addressing this feeling of disenfranchisement.

Suggestions for control and management

These stakeholders, while pro-horse, accept the need for management, at least in high alpine parts of KNP. For example, the Snowy Mountains Horse Riders Association wrote:

> *…we have always agreed that the high alpine areas are unique in this country, and that these areas as well as other areas where brumbies have not historically been found should remain horse free and we have offered to help National Parks remove the brumbies from these areas on several occasions. But we believe that other lower and hardier and more abiding areas of the mountains that have long been their home should continue to have sustainable populations.*

Similarly, a stakeholder in this grouping argued for management measures to create herds of up to 200 animals in specific localities:

> *This size {i.e. herds of 180-200 breeding animals: ITRG insertion for clarity} allows for easy management, population control and more importantly, a healthy, genetically diverse, future population. It allows for the environment to be managed alongside the horse, it reduces the pressure on the flora of the Alpine areas. In the Alpine areas of Australia, mobs of this size can be maintained in specific localities and allowed a free range, throughout the entirety of the Great Divide. Visitors viewing and study centres can be integrated, with the horses attracted by mineral blocks and water pools sunk into the ground.*
>
> *Due to past mismanagement, tough decisions of populations control will need to take effect. This cannot be arbitrary, it cannot be wholesale slaughter. It must be approached objectively with proper guidelines on selection. (what animals stay, what animals go--).*

This management impetus, however, was qualified for some stakeholders, by the need for measures to be based on a sound knowledge of changes in horse numbers and distribution over time. The Victorian Brumby Association wrote:

> *We cannot state strongly enough the need for a current accurate count of the Brumbies in the ANP before any further planning and most certainly before any acts of management are planned or undertaken. Without this information, it is impossible to distribute effort wisely and to calculate the success or otherwise of the programs undertaken.*

In fact, the submission from the Hunter Valley Brumby Association reviewed the aerial survey work that had been completed up to and including the preliminary results from 2014, saying:

> *Although it is less reliable than other methods, aerial survey has been chosen as the standard method for assessing wild horse populations within the Australian Alps. Unfortunately while some of the methods used in each of the four surveys have remained the same many things have changed, making comparison between the populations difficult. Some areas were surveyed one year and not the next, new transects were added and total survey area not only changed shape but size as well. This means important information is lost particularly about changes in population distribution, because when an area was found to have no horses in it, it was no longer surveyed. If it was continually surveyed it would be easy to see if the wild horses were changing, or more importantly increasing their distribution.*

The author of the submission, having compared past and current estimates, concluded:

> *…comparisons that have been made of wild horse density show excellent results for the management program, and considering the population growth that was predicted in 2009 if no management was implemented, it should be considered highly successful. The 2014 density is not only 40% lower than the 2009 density; it is in fact 11% lower than it was when the first survey was taken over 13 years ago.*

In commenting on management techniques, stakeholders in this category either explicitly ruled out aerial culling (e.g. Hunter Valley Brumby Association, Victorian Brumby Association, Australian Brumby Alliance), or were silent on the matter. For example:

> *The VBA is absolutely opposed to shooting uncontained Brumbies, either from the ground or the air. Aerial culling has been proven by both RSPCA NSW and RSPCA Qld to be unacceptable and inhumane. A repeat of the RSPCA taking the state government to court for cruelty should not be even contemplated as we focus on developing a best practice Brumby management program. The terrain of the ANP is heavily treed and rugged and the margin for error when taking into account shooting moving sentient beings from a moving platform in varying wind and weather conditions is simply too great.*

The Snowy Mountains Horse Riders Association supported brumby running and roping as a traditional approach that was very effective, provided it was done by professionals, not amateurs, who gave the technique a bad reputation, while a stakeholder supported further trialling this approach. Others in this stakeholder grouping, however, found brumby running unacceptable. For example, the Australian Brumby Alliance wrote:

> *Victorian Alps 'Bulk or Contract' roping is neither humane nor effective. Roped horse stress levels are significantly higher than those passively trapped. One-off roping may assist small horse numbers in exceptional situations, when conducted by a rider that can humanely apply in this method.*

The Hunter Valley Brumby Association wrote:

> *The HVBA strongly believes that Brumby Running is a cruel and out dated practice that should never be used as a control method. Particularly as horses caught by this method are psychologically unsuitable for re-homing. Abandonment of this practice is further supported by this report which found that Brumby Runners catch more pre-reproductive animals than adults and more adult females than males. As juvenile survival has only one 5th of the effect on population growth that adult survival has and adult males have more of an affect than adult females, this is not only an inhumane practice, but an unviable management tool.*

The Brumby Working Group warned that '*it would be disastrous to undertake a large cull only to experience additional negative impacts*'. Their principal suggestion for the control of wild horses was using fertility control, which they suggested while not effective in quickly reducing a population '*is a potentially more sustainable and humane option for longer-term population control strategies once a population size has been reduced*'.

1. One stakeholder argued that it was important to recognise the high country brumby as an asset and he suggested that groups of 180–200 breeding animals be maintained in specific localities of alpine areas. He proposed that there should be 'direct study and genetic testing of the various populations throughout the entire Alpine area'.
2. The Australian Brumby Alliance proposed a position that '*management objectives should flow from the fundamental position that Brumbies, in sustainable, viable numbers, not causing enduring negative impacts, should continue living wild in the KNP*'. In reviewing possible control methods, the group rejected transport to abattoirs, ground shooting and aerial shooting. They supported exclusion fencing, fertility control, passive trapping, low stress ground/aerial mustering and '*post capture outcomes*'. They noted that '*bulk or contract roping is neither humane nor effective*'. In their conclusions the group suggested that the KNP should be sectioned into '*small, distinct management areas so*

the most appropriate method can be locally applied of all the options available – different areas may need different solutions'.

3. One stakeholder noted the heritage value of the brumby but indicated that control was necessary. He suggested that brumbies should be contained to specific areas of the KNP, that numbers should not exceed 2000 in the KNP, that brumbies should be removed '*through trapping them in yards, through appropriate herding into yards through helicopters or otherwise. Brumby running should be at least trialled in some areas*' and '*brumbies should be kept away from swampy areas through using fencing*'.
4. The Hunter Valley Brumby Association recognised that control of the wild horse population was necessary, but was concerned that there may be an over-estimation of the current numbers and therefore a perceived need to use control methods that they considered not humane, '*such as aerial and ground shooting or baiting*'. They indicated that '*creation of yearly removal targets, based on keeping the population sustainable while at the same time keeping impacts to an acceptable level is extremely important*'. They suggested that '*passive trapping…is in fact extremely effective*' and that the '*humaneness of the management program is of the utmost importance*'.
5. The Snowy Mountains Horse Riders Association thought that there should be research undertaken on mountain brumbies '*that actually looks for the benefits that brumbies may offer to the environment*'. The concern of this group was that their views relating to the cultural significance of the brumby in the KNP had not been adequately considered in previous management plans. The group advocated that '*Brumby running or roping should be used as a management tool along with some trapping when and if needed in some areas*'.
6. The Victorian Brumby Association (VBA) believed that a number of options could be used to control brumby population numbers. Acceptable methods included passive trapping which the group thought currently was working well. However, they advised that '*unwanted trapped Brumbies should be humanely euthanized within 2 days*'. The group thought that fertility control using PZP was a worthwhile approach and should be trialled. Low stress mustering, including mustering with a helicopter, was something the VBA thought could have further study. Unacceptable control methods included aerial culling and ground shooting. The VBA advised that '*lethal control should only ever be considered where there are no humane, nonlethal options available*.

In general, then, these stakeholders held the view that wild horse have a place in KNP, but that management of wild horses is a legitimate aim in KNP, while arguing the need for a firm basis in data, and preferring to limit the methods of control used, with some differences of opinion over suitable control methods.

Group C – against horses in KNP, but stating management of horses, not eradication, as the goal

There were six stakeholder groups or individuals falling into this group. They included a group of scientists from the Fenner School, the ANU, the Canberra Bushwalking Club, the Southern Ranges Regional Advisory Committee, and some individuals. The views in this category may be characterised as regarding wild horses as problematic in KNP, but seeking improved management to mitigate impacts, rather than explicitly advocating eradication from KNP. In terms of horses as being a problem, one submission contrasted the biodiversity in KNP with that found in the ACT's Namadgi National Park:

> *The first walk was a long planned two week walk with friends on the Australian Alpine Walking Track (AAWT). We started in the ACT from Namadgi visitor center with the plan to walk through to Thredbo. At the start we enjoyed two days of walking through Namadgi National Park with its abundance of native animals. Then we crossed into Kosciuszko National Park and were quite astonished at what we found. Most of the AAWT followed fire trails which apparently are used by hundreds, perhaps*

> *thousands, of feral horses. The AAWT route was often completely covered with layers of horse manure.*

A submission by the Fenner School scientists stated:

> *The grazing, trampling, compacting and soil pugging impacts were observed to have enhanced erosion of stream banks, bogs and fens and have directly impacted habitats of rare, threatened and endangered Australian native species and could help lead to the loss of Australian species. There are too many pest horses; they are increasing in numbers; they are excessively impacting Australian native animal habitats and they are severely degrading the headwaters of our most important rivers. We conclude that urgent and effective action is needed to end forever these pest horse impacts; to restore the damage to the water catchments and to help conserve Australia's native species.*

But these same authors also wrote:

> *Both authors have the highest regard for horses and appreciate and support their place in most areas of Australia such as farms, towns and sporting tracks. We understand, appreciate and share the delight and companionship horses bring to many people. This report is not an attack on horses per se. Rather; it is about raising awareness of too many horses and unacceptable and excessive impacts in one of Australia's most important conservation areas, the Australian Alps national parks.*

Similarly, the Canberra Bushwalkers wrote:

> *As frequent bushwalkers in KNP, the members of the Canberra Bushwalking Club (CBC) have an active interest in promoting the park's environmental values, while ensuring that this is carefully balanced with the humane treatment of the wild horses.*

They further wrote:

> *We would strongly encourage the ITRG to consider both shorter-term and longer-term control options, possibly even a two-step approach of measures to bring the numbers down to a level that minimises environmental damage followed by measures to hold numbers at that level.*

The Southern Ranges Region Advisory Committee acknowledged the cultural significance of wild horses and their tourism potential:

> *Some visitors who come to see Kosciusko NP want to see 'brumbies', and for some it is a thrill to experience these horses in a wild environment. Local tourism bodies promote the opportunity to see 'brumbies' in the wild as an icon with historical significance through the 'Man from Snowy River' and grazing in the high country. However, other visitors do not wish to see wild horses as they consider them to be out of place in a national park and are aware of the damage they do to the environment.*

They suggested a solution:

> *One possibility is to maintain a small population of wild horses to maintain cultural values, although managing a herd of non-native animals may be inconsistent with the purpose of national parks as set out in the* National Parks and Wildlife Act 1974 *Section 30E. Such a population could be located outside of Kosciuszko NP and funding could be provided by sale of horses, private individuals, organisations which support wild horses or corporate sponsors. Examples of managed herds outside national parks include Coffin Bay in South Australia and Guy Fawkes in NSW.*

Suggestions for control and management

In terms of methods of control, Group C stakeholders did not explicitly rule out aerial culling; and one individual advocated it. In general, however, these stakeholders were not particularly directive about management techniques to be used.

A number of groups that submitted proposals to the ITRG noted the anecdotal apparent increase in horse numbers over a 40–50 year period and the concomitant adverse impact on the environment, particularly waterways. There was recognition by all groups that there was a need for humane control of horse numbers in the KNP.

The Canberra Bushwalking Club noted that '*the wild horse management methods currently in use in KNP – and the budget available – are not sufficient to achieve adequate control over the adverse environmental impact of the horses*'. One suggestion that they made was for '*community partnerships for monitoring the environmental impact of wild horses, as a possible cost-effective way of generating data on an ongoing basis*'.

The Southern Ranges Region Advisory Committee (SRRAC) supported the use of trapping and rehoming of wild horses but suggested that '*trapping removes an insufficient number of horses to effectively reduce the environmental impacts and that the demand for re-homing will reach a saturation point*'. The group supported low stress mustering techniques but noted the '*risks, stress to animals and costs*'. The SRRAC supported aerial control but noted that '*this will need community and political support before it can proceed*'.

Group D – against horses in KNP, and advocating eradication rather than ongoing management

This grouping included 10 stakeholder groups or individuals. These included the Colong Foundation for Wilderness, the Nature Conservation Council, the National Parks Association of NSW, and the National Parks Association of the ACT. Stakeholders in this group not only view horses as problematic in KNP, they also view talk of any management of horses short of eradication as unacceptable. For example, the Colong Foundation for Wilderness wrote:

> *The technical reference group must not take account of stakeholder views that defeat the primary conservation purpose of the national park. Retaining a managed herd is contrary to the management principles and obligations to control feral animals that are specified in the* National Parks and Wildlife Act 1974*.*

The Nature Conservation Council wrote:

> *Given that the primary function of national parks is the conservation of native species and ecosystems the eradication of feral horses should be the overarching management objective, and must be given significant priority.*

Similarly, the National Parks Association of NSW wrote:

> *The NPA believes that the scientific (and anecdotal) evidence overwhelmingly demonstrates that feral horses are causing severe damage to KNP, including to nationally threatened species and ecosystems. Therefore the NPA's view is that eradication of feral horses should be the management objective—as it should be in the case of all pest animals and plants where practicable—and that the NPWS should now act decisively to implement management to this end.*

For Group D stakeholders, even where they recognise the cultural value of wild horses, eradication must be the goal, with little room for compromise. For example, the Nature Conservation Council wrote:

> *While we recognise the heritage and cultural sentiment relating to feral horse populations, in our view the unique ecological significance of our sensitive protected areas, including the Kosciuszko National Park must be paramount. Protected areas must be managed in accordance with the objects of the* National Parks and Wildlife

> Act 1974 *to conserve nature. The Nature Conservation Council recommends ground and aerial shooting under strict protocols (e.g. FAAST protocols for aerial shooting) in combination with other methods as a humane and effective means of eradicating pest horses from national parks.*

Suggestions for control and management

The groups that submitted proposals to the ITRG noted that there were a number of challenges to controlling wild horses but that there were a range of methods available, all of which were considered by the ITRG. In general, the submissions from this group were supportive of aerial culling of wild horses, in view of the relative failure to reduce numbers by the methods used to date.

The Colong Foundation for Wilderness noted that '*feral horses should be managed for pest eradication by using the most effective, least ecologically damaging and most humane control methods available*'. The group did not support control methods used previously that were ineffective, and indicated that the population of horses '*on-park should approach zero in the shortest possible time*'. To do this, they indicated that the only option was shooting horses from helicopters. This view was also supported by the Nature Conservation Council of NSW, which also advised that ground shooting should be considered. They noted that these should only be undertaken '*under strict protocols…in combination with other methods as a humane and effective means of eradicating pest horses from national parks*'.

Miscellaneous submissions

Four submissions fell into this category: Animals Australia, StockWHIP, the Invasive Species Council of Australia, and the Snowy Mountains Brumby Sustainability and Management Group. All these provided no opinion on the presence of horses in KNP. One, Animals Australia, wrote that where any pest animal needed to be controlled, it should be humanely done:

> *A primary concern is where inhumane, quick fix, and cheapest solutions to pest animal problems are used. Time and time again, we have seen pest animals suffer for very little real gain, when what is needed are humane, effective, scientifically based long-term management programs.*

Another stakeholder, the StockWHIP Program, wrote of the opportunity represented by wild horse rehoming for prisoner rehabilitation:

> *The Wild Horse Incarceration Prevention Program will receive wild horses from Kosciuszko National Park and other impacted lands. It is modeled on similar, highly successful, programs currently operating in US, Canada and South Africa. These programs have demonstrated benefit to both horses and participants.*
>
> *Program participants will come from category C3 prisoners who are at risk of reoffending upon release. Participants will be selected through an application process to be facilitated by their case manager.*
>
> *The program will foster rehabilitation by training the participants in horse management, and then in turn, utilising these people to train the wild horses to a level where they are saleable. The centre will further develop the self-esteem and skills of the participants by offering additional vocational training whilst in the program.*

The Snowy Mountains Brumby Sustainability and Management Group argued that the timelines for submission to the ITRG were too tight and they lacked scientific advice and resources to make a suitable submission. The Invasive Species Council of Australia stated that they were willing to trust the ITRG process to come up with acceptable outcomes.

Appendix C: Assumptions about the various control methods on which the humaneness assessments were based (cf. Table 7)

METHOD	ASSUMPTIONS
Passive trapping	**Carried out in accordance with SOP HOR004 Trapping of feral horses** Trapping is avoided during foaling periods or when females are heavily pregnant Assessment applies from when the horse enters the trap until when the trap gate is opened for removal/loading for transport or until immediately before they are humanely killed on site within the trap
Mustering	**Carried out in accordance with SOP HOR003 Mustering of feral horses** Separate assessments of mustering small groups (<50) and large groups (≥50) of horses Completed within daylight hours Feed and water are provided on completion Occurs within a small area (i.e. max. 2 km) where horses are not pushed outside of their home range Aerial and ground mustering used in combination A skilled operator with an appropriate firearm licence is always readily available with a suitable calibre firearm to euthanase any injured animals Multiple bands are mustered with an accumulation of one to four bands typical Applies from the beginning of contact with the horses, through to when they are contained in yards until the gate is opened to move horses onto the next stage
Roping (Brumby running)	**No SOP for this method: *Parks Victoria Roping Operating Guidelines 2013* used as a guide** Involves two or more riders pursuing a target horse, roping it around the neck to bring it under control and tying it to a tree to settle before removal Horses are not roped when temperatures exceed 30°C Muzzled dogs may be used to assist in the location of wild horses but not for catching or loading There is no restriction on the duration of pursuit Horses can be left tied for up to 24 hours Applies from the start of the pursuit to the point at which the captured horse is released from being tied up
On-site humane killing	**No SOP for this method** Horses are killed with a shot to the head using a firearm and ammunition adequate for shooting horses at short range (i.e. within 5 m)

METHOD	ASSUMPTIONS
Loading and transport	**Carried out in accordance with Australian Animal Welfare Standards and Guidelines – Land Transport of Livestock** Separate assessments of: • **short journeys** – a single journey lasting no longer than 4 hours • **long journeys** – a single journey lasting up to 24 hours A skilled operator with an appropriate firearm licence is always readily available with a suitable calibre firearm to euthanase any injured animals Contingency plans are in place to care for animals in the case of a truck breakdown during transportation Horses are segregated into appropriate groups to reduce aggression and partitions or pens are used to separate unfamiliar groups when transported together Note that the Land Transport Standards state that all stallions should be segregated during transport, however the view of the assessment panel is that for wild (rather than domesticated) horses, in some instances, stallions should be kept with their familiar group Transport vehicles provide protection from wind chill when cold and direct sunlight when hot Applies from when the horses are loaded for transportation to when they are offloaded at their destination
Lairage and slaughter	**No SOP for this method: used the *National Animal Welfare Standards for Livestock Processing Establishments*** Applies after unloading, from the holding of horses in yards at the abattoir (lairage) up to the point of death in the slaughter room
Ground shooting	**Carried out in accordance with SOP HOR001 Ground shooting of feral horses** Separate assessments of: • **chest shots** – point of aim is the chest (heart/lung area) • **head shots** – point of aim is the head (brain) The shooter is competent and makes accurate decisions about whether the shot can be successfully placed Shooting of individuals stops when the flight response of the herd limits further accurate shooting (except when a mare is shot that has a dependent foal; the shooter must wait until the foal returns so it can be shot) Older females are always shot first
Aerial shooting	**Carried out in accordance with SOP HOR002 Aerial shooting of feral horses** Separate assessments of two scenarios: • **Scenario 1** – the horse is chased for <1 minute, the first shot hits the cranium and the animal is immediately rendered insensible. The animal is then shot again in the thorax or cranium and is killed without ever regaining consciousness • **Scenario 2** – the horse is chased for >5 minutes and is shot and not killed (wounded), regains consciousness and then is shot again one or more times resulting in death All animals in a social group are targeted The shooter is competent and makes accurate decisions about whether the shot can be successfully placed All animals are always shot at least twice to ensure death

METHOD	ASSUMPTIONS
Fertility control with GnRH vaccine	**No SOP for this method** GnRH vaccine can be administered by a dart or by hand injection to a confined animal Mares aged 5–10 years are the targets for the vaccine Some females in each band are left unvaccinated
Fertility control with PzP vaccine	**No SOP for this method** Liquid PZP formulation can be administered using a dart or by hand injection to a confined animal Pelleted PZP must be injected by hand to a confined animal Mares aged 5–10 years are the targets for the vaccine Some females in each band are left unvaccinated
Fencing	**No SOP for this method** Used on a small scale to strategically exclude horses from specific areas Not used to specifically prevent access to food or water Standard cattle fencing with straight plain wire (not barbed) is used