Pest animal risk assessment

Feral horse

Equus caballus

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Front cover: Feral horses (photo courtesy Robert Ashdown, Queensland Department of Environment and Resource Management).

Contents

Summary

Domestic horses arrived in Australia with the First Fleet in 1788. The first record of escape or release was in 1804. Feral horses were first recognised as 'pests' in the 1860s. Currently, there may be more than 400 000 feral horses in Australia, with at least 100 000 in Queensland. It is unclear if numbers are increasing, or simply fluctuating in response to variable rainfall. Thousands are known to die during droughts.

Feral horses compete for food with cattle, damage native plants and water holes within national parks and provide a potential reservoir for exotic diseases such as equine influenza. Their impact appears particularly significant during drought when large numbers congregate at drying water holes, competing for water with cattle and damaging refugia for native animals and plants. However, the total impact of feral horses in Queensland requires further study and quantification, since little data currently exists to guide decision making and prioritisation.

While most feral horses in Queensland inhabit arid and semi-arid western and northern parts of the state, they can also persist in forest country along the east coast, including areas close to Brisbane.

It is difficult to predict if the feral horse population in Queensland will increase in the future. On the one hand, the population has been expanding for the last 100 years and has probably had sufficient time to reach the land's maximum carrying capacity in some parts of its total range. Supporting this hypothesis is the fact that, in some areas at least, the population appears to be fluctuating in response to rainfall. On the other hand, there seems to be potential for increased abundance in forested parts of central, eastern and south-eastern Queensland, where numbers are currently patchy. Hence, the total negative impact of feral horses in Queensland might increase above current levels in favourable years, when widespread rainfall improves recruitment and avoids heavy losses caused by drought. Localised increases in impact seem most likely in forested areas in central, eastern and south-eastern Queensland.

Controlling feral horses often generates significant animal welfare concerns and can be a complex issue. However, effective control options are available.

Introduction

Taxonomy

Species:	*Equus caballus* Linnaeus
Common names:	feral horse, brumby, wild horse
Order:	Perissodactyla
Family:	Equidae
Related species:	*Equus africanus* (African wild ass)
	Equus africanus asinus (donkey)
	Equus asinus (ass)
	Equus burchellii (Burchell's zebra)
	Equus caballus przewalskii or *E. ferus przewalskii* (Przewalskii's wild horse)
	Equus ferus (Tarpan horse)
	Equus grevyi (Grevy's zebra)
	Equus hemionus (kulan)
	Equus kiang (kiang)
	Equus quagga (quagga)
	Equus zebra (mountain zebra)

The modern horse was domesticated 2500–5000 years ago from its wild ancestors, including the Tarpan horse (*Equus ferus*) and Przewalskii's horse (*Equus caballus przewalskii*), two species that are now extinct in the wild (Dobbie et al. 1993). The exact date of domestication is subject to debate and mitochondrial DNA analysis suggests that domestication may have occurred independently at multiple sites across the world (Pennisi 2001, cited in Walter 2002).

Description

Morphologically, feral horses are no different in general appearance to domestic horses. Both forms are variable, depending on breeding and origin of parent stock. Horses are large herbivores, with long, strong legs that are well adapted for long-distance travel in search of food and water. Average size is around 1.5 m head height and 1–1.6 m shoulder height. Average weight is 350–450 kg. Coat colour is variable, ranging from white, tan, brown, or black to patches of oranges and browns on white. Coat hairs are short and fine, growing longer in winter. The tail is relatively short but has long hairs that can reach the ground. There is also long hair along the neck (mane) and forehead (forelock). Long legs facilitate efficient travel across open grassy plains.

Biology

Life history

Gestation period: average 336 days

Young per birth: 1

Birth interval: 548 days

Weaning: 274 days

Sexual maturity: females 914 days, males 973 days

Sexual activity: 20 years, oldest recorded 31 years

Life span: oldest recorded 57 years. Average lifespan is 25–30 years

(AnAge Database, undated; Groves, 1989; Wikipedia, 2009a)

Both males and females can reproduce at an early age (18 months–3 years), but females do not physically mature until about four years of age, and males generally do not breed until they have achieved dominance at about five years of age. Females older than four years are referred to as 'mares', and non-castrated males older than four years are referred to as 'stallions'.

Infertility often occurs during the mare's first oestrus; however, pregnancy rates subsequently exceed 90%. Foaling is generally in spring and summer. A new-born foal is kept in a quiet place and not introduced to the rest of the social group until it is nine days old. Foals are weaned gradually, sometimes not being fully dependent on solids until they are two years old, although this is unusual.

A post-partum oestrus occurs in the female, with mares returning to heat 9–14 days after giving birth. Therefore, they may be pregnant and lactating at the same time, and breeding often occurs at the same time as foaling. Sex ratio is about even at birth, but male mortality is greater at all ages and adult sex ratio may be expected to be about 1:2 or more. The rate of twinning is very low. Feral horses in Australia produce on average one foal every two years (Dobbie et al. 1993; Groves, 1989; Wikipedia, 2009a).

Social organisation

Feral horses tend to form small social units, either in a harem, which consists of a dominant stallion, his mares and their offspring, or in a bachelor group, a group of one to three males comprising mainly two- to four-year-olds who have been forced out of their natal harem groups. Young females experiencing first oestrus are usually ignored by the dominant stallion and often leave their groups. Females may remain unattached for up to a year before forming a harem with a bachelor male or joining an existing harem. A female is likely to stay in the harem in which she first becomes pregnant. Mares may bond closely and participate in mutual grooming.

The stallion is somewhat peripheral to the mare group and participates infrequently in grooming interactions, instead acting as the group's buffer from the outside world. He is more

alert than the mares, gets less sleep and is more nervous and restless even when grazing. He defends the herd against attack, generally fleeing last and nipping the rumps of lagging foals to make them keep up. He also defends the harem against other males. When the females have returned to the herd after dropping their foal, the stallion is especially active, driving them and attempting to mate when they come into oestrus. Other stallions are fiercely fought; the hind feet are used to lash out backwards, the incisors to slash, and they rear to strike with the forefeet.

Small social groups tend to coalesce into large herds of 100 or more horses at watering points during drought. When groups come into close contact, stallions will posture and threaten other stallions. Interactions can sometimes escalate into fights and chases. Intergroup dominance hierarchies have often been observed at water sources, and more dominant groups will gain access before other groups.

Feral horses are diurnal and crepuscular. They may seek out shade during the middle of the day (Dobbie et al. 1993; Groves, 1989; McCort, 1984).

Harem groups, bachelor groups, and all-female groups usually occupy home ranges, with well-defined boundaries. In central Australia, feral horses have a home range of about 70 km², and horses in the Australian Alps are thought to have smaller home ranges of about 32 km². Horses resist being moved from their home area, for example during mustering (NSW National Parks and Wildlife Service, 2003).

For further information on social organisation and behavior of feral horses see McCort (1984).

Diet and feeding behaviour

Horses are non-ruminant herbivores. They constantly graze, eating approximately 2–2.5% of their body weight daily. Roughage is broken down by microbial fermentation in the caecum and large colon. Feral horses may spend 51–75% of their time feeding. They prefer to feed in areas with the greatest concentration of high quality green food. Grasses are preferred, but they will also consume green or dead perennial herbaceous plants, roots, bark, buds, and fruits. Horses are selective feeders and may walk up to 50 km from water to find suitable feed. In central Australia, feral horses graze near drinking water if feed is plentiful, although as feed is depleted they are forced to forage further from water to areas that are less intensively grazed by other herbivores. Horses need to drink at least 45 litres of water each day. Harem stallions, mares and foals require reliable resources and generally favor areas surrounding permanent waterholes. Bachelor groups are more mobile and more readily occupy areas where water is less reliable, needing to maintain only their own condition for growth. They probably return to more predictable areas for food and water when they are old enough to acquire mares, or in periods of drought. Horses relying solely on temporary waters are more prone to perish during drought (Dobbie et al. 1993; NSW National Parks and Wildlife Service, 2003; Wikipedia, 2009a).

Preferred habitat

Feral horses are capable of occupying a wide range of habitats although they are best adapted to open grassy plains. In Australia, feral horses inhabit country ranging from deserts, semi-desert plains, rocky ranges, tropical savannah grasslands, forests, scrubs, subalpine mountains, small offshore islands and even some wetlands (Figures 1 and 2).

In western arid areas of Queensland, large numbers occur in sand hill areas and plains with low mulga scrub.

Feral horses are commonly found in areas of low pastoral value away from the more intensively managed areas, although they usually select the best country on which to graze. While feral horses tend to prefer grassy flats, they readily retreat to hill country to escape drought or mustering activities (Dobbie et al. 1993).

Figure 1. Feral horses in Kakadu National Park, Northern Territory
(photo: C. Goodwin. Image from Wikimedia Commons under a GNU Free Documentation Licence).

Figure 2. Feral horses in forest country in Central Queensland
(photo: courtesy Robert Ashdown, Queensland Department of Environment and Resource Management).

Predators and diseases

There are no known predators of feral horses, although in Australia it is possible that dingoes or wild dogs occasionally take foals.

Horses are susceptible to a range of exotic diseases including a number that are not yet established in Australia. Examples include: African horse sickness, borna disease, bovine brucellosis, contagious equine metritis, dourine, epizootic lymphangitis, equine babesiosis, equine encephalosis, equine influenza, equine morbillivirus pneumonia, equine viral encephalomyelitis, getah virus disease, glanders, Japanese encephalitis, louping ill and other tick-borne encephalitides, Potomac fever, rabies, screw-worm fly, surra, trichinellosis, vesicular stomatitis and warble-fly myiasis (Geering et al. 1995). As such, feral horses are a potential reservoir of exotic diseases (Dobbie et al. 1993).

On average, 20% of the feral horse population dies each year, mainly from drought, poisonous plants and parasites. Few feral horses reach 20 years of age. The maximum possible rate that feral horse numbers can increase is 20–25% per year (NSW National Parks and Wildlife Service, 2003).

History of introduction

Horses first arrived in Australia with the First Fleet in 1788 (Kennedy, 1986). Irregular shipments followed. The first record of horses either escaping or being abandoned was in 1804. Minimal fencing combined with infrequent musters led to the growth of feral herds of abandoned and stray stock. Feral herds were first recognised as a pest in the 1860s. As with other large utility species, many horses became redundant with the increase in mechanisation, giving rise to large unmanaged herds, particularly in extensive cattle-raising areas (Dobbie et al. 1993).

Distribution and abundance

Australia

Australia has the largest population of feral horses in the world, estimated at more than 400 000 (Dawson et al. 2006), scattered across a vast area that includes parts of the Northern Territory, western and northern Queensland, the arid zone of South Australia, and the northern rangelands of Western Australia (Figure 3). There are isolated populations in New South Wales and Victoria, and occasional incursions into the ACT (Dawson et al. 2006). Within their Australian range, feral horses tend to be most abundant in unfenced cattle production areas of the Northern Territory and Queensland (Lundie-Jenkins et al. 2006).

Figure 3. Distribution of feral horses (*Equus caballus*) in Australia (source: www.environment.gov.au/biodiversity/invasive/publications/pubs/feral-horse.pdf).

Queensland

In Queensland, feral horses are most abundant in Cape York, the north-western part of the Queensland–Northern Territory border, Carnarvon National Park and an area south of Maryborough (Figure 4).

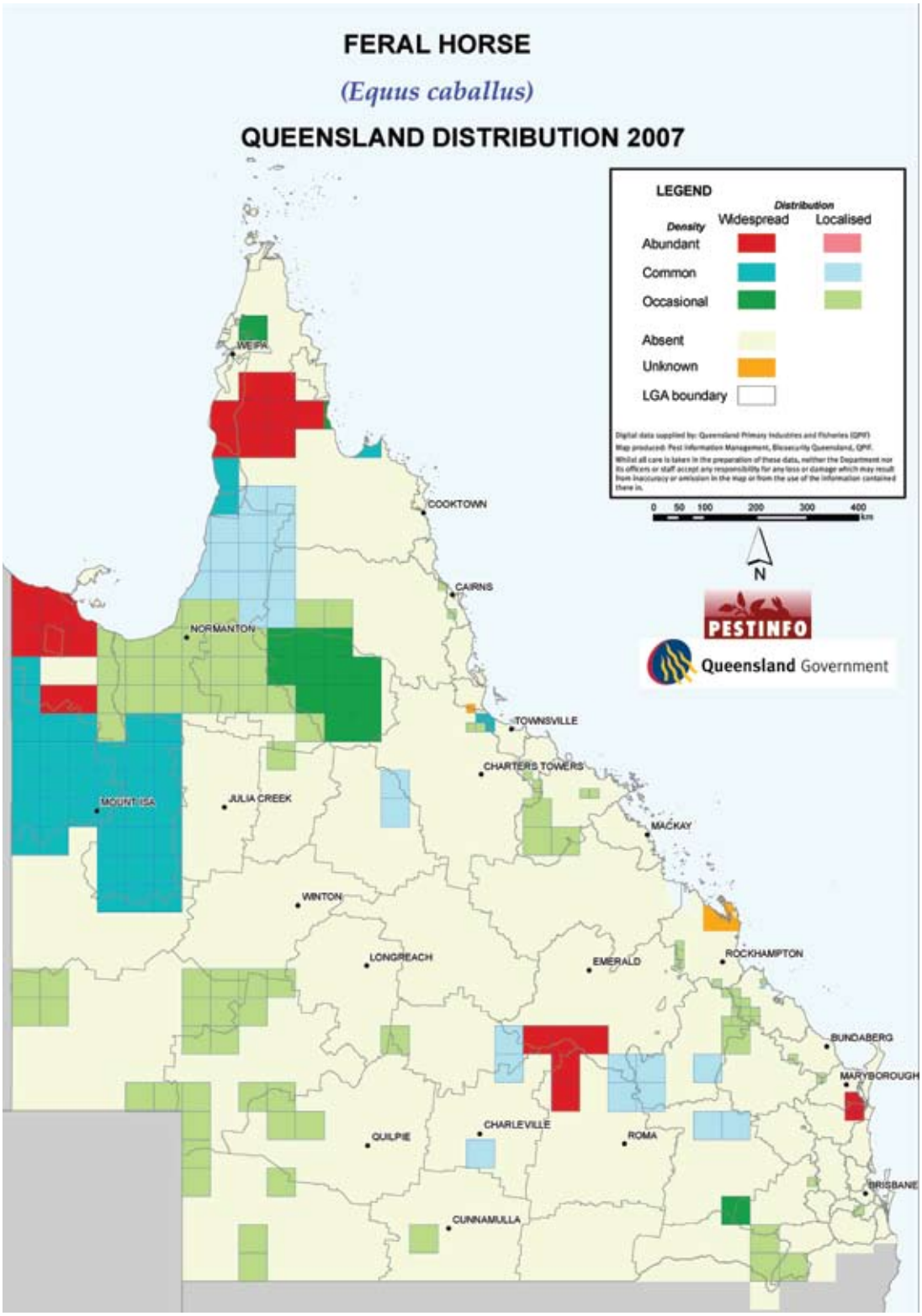

Figure 4. Distribution of feral horses (*Equus caballus*) in Queensland in 2007 (source: www2.dpi.qld.gov.au/extra/pdf/IPA-maps/IPA-Feral-horse-State-2007.pdf)

Mitchell et al. (1985) estimated there could be as many as 100 000 feral horses in Queensland. More recent estimates have not been made.

Abundance varies spatially and temporally, depending on a range of factors including habitat suitability (availability and quality of food), availability of water and social structure. In the arid zone, the availability of water is perhaps the dominant factor affecting distribution and abundance, as it directly affects survival during drought. Of course, the supply of suitable food can vary dramatically from season to season, depending on rainfall patterns. Where feral horses exist in groups, comprising a single dominant stallion with mares and foals, their home range can cover up to 100 km^2. However, single bachelor stallions are nomadic.

Feral horses exist in most land types that are not intensively managed (D. Berman pers. comm. 2006).

In Queensland, data on abundance have tended to be collected in areas where feral horses are having undesirable impacts, as follows:

- Gatton Shire Council (South East Queensland) trapped 114 feral horses in the Murphy's Creek Ballard district in 2005, with the intention of de-stocking the area to placate residents' complaints of feral horses threatening people, ruining fences and posing a danger to motorists (ABC News Online, 2005).
- In November 2005, 977 feral horses were removed from the Townsville Military Training area, with a further 593 taken in April 2006 (Alan McManus, pers. comm. 2006). Fifty-two horses were removed from the Greenbank Military Training Area (near Brisbane) from 2004–06, with as many as 40 horses remaining (Berman, 2006).
- Feral horses are present in commercial forests along the Fraser Coast and near Beerburrum (Sunshine Coast Hinterland). A survey of feral horse abundance in the Tuan and Toolara state forests was conducted in 2002. The number of feral horses in the area was estimated at 181 (Crittle and Jackson, 2004). The density of feral horses in the Beerburrum State Forest was found to be 1.5/km^2, which equates to approximately 76 feral horses in the area (Berman and Brennan, 2006).
- In the Clemant State Forest north of Townsville, an aerial survey in 2006 estimated 120 feral horses (Queensland Parks and Wildlife Service, 2007).
- The Queensland Parks and Wildlife Service (QPWS) has removed more than 5000 feral horses from national parks since the 1980s, including animals from Fraser Island. An estimated 12 000 feral horses are in Carnarvon National Park (Lundie-Jenkins and Manning, 2006).
- An aerial survey of feral horse abundance in the Carnarvon National Park in February 2006 estimated 4400 horses over 3240 km^2 of parkland, and about 12 600 horses across the larger area of Carnarvon National Park and neighbouring properties (8330 km^2). This larger population comprised approximately 88% adults, 9% yearlings, and 3% foals. In this area, feral horses are now considered to be more abundant and widespread that at any other previous time. This population is considered large enough to be regionally and nationally significant (Lundie-Jenkins et al. 2006).

Overseas

In the past, the natural range of *Equus ferus* ('tarpan' or 'wild horse'), one of the ancestors of today's domestic horse, ranged across Eurasia, from eastern Poland and Hungary east to northern Turkestan and Mongolia (Long, 2003). Another ancestor, *Equus ferus przewalskii* ('Przewalskii's horse') is now extinct, with the last survivors in south-east Chinese Turkestan probably existing until about 1969.

Feral populations of the modern domestic horse exist in France, Greece, Portugal, Spain, Sri Lanka, Iran, United States of America, Alaska, Canada, Mexico, Columbia, West Indies, New Zealand, Hawaii, Galapagos, Africa, United Kingdom, Russia, South America (Argentina, Chile and Patagonia), Falkland Islands, Kerguelen islands and Hispaniola (Lever, 1985; Long 2003).

History as a pest overseas

Following domestication, horses were transported across the world for use as domestic animals. Domestic horses subsequently escaped or were deliberately released, forming feral and semi-feral populations in numerous places (countries listed in previous section). In some countries, feral horses are strictly managed, and in some places protected, as they are considered to be a resource. In other areas they are unwanted pests, mainly where they compete with more valuable livestock, such as cattle, and cause expensive damage to fences and watering points (Long, 2003).

In New Zealand, horses were introduced in 1814, and wild horses were reported in the Kaimanawa mountains on North Island by 1876 (Wikipedia, 2009b). The descendents are now known as Kaimanawa horses. A study of their impacts found that trampling and grazing fractured the saturated turf, causing downslope sedimentation, water ponding, and opportunities for the establishment of weeds. A number of habitat types, including rare plant habitats, have been degraded by grazing feral horses (Rogers, 1994). To reduce their impact, the herd was reduced significantly in 1997 to about 500. Since then, routine musters are undertaken to contain the herd within the chosen boundaries and to remove a number equivalent to the annual population increase (Department of Conservation, 2004).

In the United States, feral horses are often considered part of the natural heritage of the American West, and as such, feral horses are protected under the *Wild Free-Roaming Horses and Burros Act 1971*. Populations are currently managed by capturing excess animals and offering them for adoption (Wikipedia, 2009c). Populations are suppressed to minimise ecological impacts.

A study in Nevada (United States) found that plots around springs that were protected from horses had significantly higher plant species richness, percentage ground cover, and abundance of grasses and shrubs, as well as more small mammal burrow entrances, compared with horse-grazed springs (Beever and Brussard, 2000). Subsequent research found that in areas where horses were removed, ants and ant mounds were more abundant (Beever and Herrick, 2006).

At a salt marsh site, grazing and trampling by feral horses reduced above-ground biomass by 50–55%. The abundance of periwinkle snails (*Littorina irrorata*) was also reduced (Turner, 1987). A further study of salt marshes in the United States found that areas grazed by feral horses had less vegetation, a higher diversity of foraging birds, higher densities of crabs, and a lower density and fish species richness, compared with horse-free marshes (Levin et al. 2002).

Grazing by feral horses on Assateague Island (United States) was found to significantly alter dune morphology and cause unnaturally high rates of dune erosion (De Stoppelaire et al. 2004).

Research in a grass steppe area of Argentina found that feral horses increased predation of bird eggs from 12.5% (ungrazed) to 70% (grazed). It is thought that grazing increases the visibility of bird nests, increasing predation and having a significant impact on the population dynamics of local grassland birds (Zalba and Cozzani, 2004).

Current impact in Australia and Queensland

While there have been few scientific studies to quantify the impacts of feral horses, there is a general perception among land managers that feral horses have a range of significant impacts on native ecosystems and agricultural systems. Much of this is based on years of visual observation.

As outlined by Dawson et al. (2006), Dobbie et al. (1993) and Weaver (2007), general impacts on native environments include:

- removal of native vegetation by grazing and trampling, with flow-on effects to native wildlife (Figures 5 and 6). Research in Carnarvon National Park recorded a loss of native plant biomass of 12 400 tonnes/year across the entire park. Another study found that macropods and native rodents are more abundant in areas where there are less feral horses (Nimmo and Miller, 2007).

Figure 5. An aerial view of a 2500 m² plot on the Buckland Tableland (Central Queensland) where feral horses have been excluded by fencing. Areas outside the fenced plot show the extent of ground cover loss caused by feral horses (photo: courtesy John Augusteyn, Queensland Department of Environment and Resource Management).

Figure 6. A ground-level view of the same exclosure plot shown in Figure 5. The fence does not exclude other herbivores such as macropods (photo: courtesy John Augusteyn, Queensland Department of Environment and Resource Management).

- soil erosion, soil compaction and track formation (Figure 7).
- suspected modification of natural fire regimes (frequency and intensity) potentially caused by the removal of ground fuel, with resultant increases in woody plant abundance.
- reduction of water quality in streams, water holes and springs due to trampling of stream banks and fouling of water holes. For example, some springs in Carnarvon National Park have lost their aquatic and littoral vegetation and most biological activity due to feral horse activity (Figure 8).
- suspected dispersal of weed seeds in dung, manes and tails.

Figure 7. Localised erosion caused by concentrated grazing by feral horses in Central Queensland (photo: courtesy Robert Ashdown, Queensland Department of Environment and Resource Management).

Figure 8. Damage to water hole caused by feral horses in Central Queensland (photo: courtesy Ross Perry, Queensland Department of Environment and Resource Management).

Research by Melzer and Whitehead (2008) found that some areas can recover after feral horses are removed. However, it is likely that in ecologically sensitive areas, such as dune systems of the arid zone, and areas with rare or threatened flora and ground dwelling fauna, feral horses could cause long-term impacts and these areas may never fully recover.

Specific impacts in a number of national parks and state forests in Australia are summarised below:

- In Kosciuszko National Park (New South Wales), heavy grazing and trampling by feral horses is causing significant damage to alpine herbfields, bog and fen communities.
- In Guy Fawkes River National Park (New South Wales), feral horses are chewing the bark of eucalyptus trees, reducing tree health (Schott, 2002).
- In Clemant State Forest (Queensland), feral horses are trampling vegetation, damaging creek banks and waterways and posing a danger to drivers on the Bruce Highway (Queensland Parks and Wildlife Service, 2007).
- A study in the Buckland Tableland (Carnarvon National Park, Queensland) compared experimental plots that were protected from grazing by horses with unprotected plots, and also compared areas before and after a cull of horses. Plant biomass was greater in plots protected from grazing. Similarly, following a cull, plant biomass increased as regeneration occurred (Melzer and Whitehead, 2008).
- In Carnarvon National Park, feral horses damage Indigenous cultural heritage sites by raising dust and by licking and eating the artwork (Weaver, 2007).

As outlined by Dawson et al. (2006), Dobbie et al. (1993) and Weaver (2007), agricultural impacts of feral horses include:

- competition with cattle for food and water. One feral horse consumes plant matter comparable to that consumed by one to two cows. Lost Australian beef production has been estimated at $30–$60 million per year. Large numbers of feral horses have been shot in the western regions of Queensland to reduce damage to fences and competition for feed and water. One station alone shot 3000 feral horses to reduce competition with domestic stock.
- soil degradation caused by overgrazing and trampling, mainly around water holes
- damage to watering points, particularly during drought, as well as damage to fences
- disruption to station horses during stock mustering (feral stallions may take mares from station stocks and upset breeding programs)
- a reservoir for exotic diseases such as equine influenza. In Queensland, feral horses are a threat to cattle tick control strategies.

Feral horses are considered to be 'pests' where they occur in large numbers, but in the central and eastern regions where lower numbers occur they are sometimes considered an asset—as a source of horses for domestic purposes or for the pet meat industry (Mitchell et al. 1985). Increased utilisation of feral horses to provide pet meat is occasionally suggested. However, a feasibility study in Burke Shire suggested that transport costs were prohibitive (Mitchell et al. 1985).

In some areas of Queensland, feral horses can have social impacts. In national parks, they can wander through campsites, leave dung piles, confront or threaten visitors, and contaminate water supplies through faecal contamination (Dawson et al. 2006).

Threat to human safety

Feral horses have the potential to cause serious motor vehicle accidents when they cross roads (Dawson et al. 2006).

As feral horses often have limited or no experience with human interaction, they may view people as predators and react to them with extreme fear, flight responses, or defensive aggression (Bertone, 2006).

In remote areas of national parks, there is concern about the safety of visitors that may be confronted with an aggressive stallion (Weaver, 2007).

Value as a resource

In some parts of Australia, feral horses are commercially harvested for pet meat and human consumption (export only). They can also be mustered and trained as work or recreational horses.

A survey found that 68%, 71% and 90% of people in northern, north coast and western Queensland respectively, regarded feral horses as a pest; 86% and 78% of people on the east coast and in Central Queensland, respectively, felt that feral horses were not a pest (Mitchell et al.1985).

In alpine areas of Australia, feral horses might be contributing to the region's tourism appeal, due to the romance associated with wild brumbies combined with their place in Australian history. In other areas, Indigenous Australians perceive feral horses as an important resource, with opportunities for employment and cash return (Dawson et al. 2006, Dobbie et al. 1993).

Conservation status

Equus caballus is not listed on the IUCN Red List nor is it listed on a CITES appendix.

Potential distribution and impact in Queensland

Climate is a primary factor that determines a species' distribution. Climate-modelling software (CLIMATE version 2) was used to predict the area of Australia where climate is considered suitable for *Equus caballus* (Figure 9).

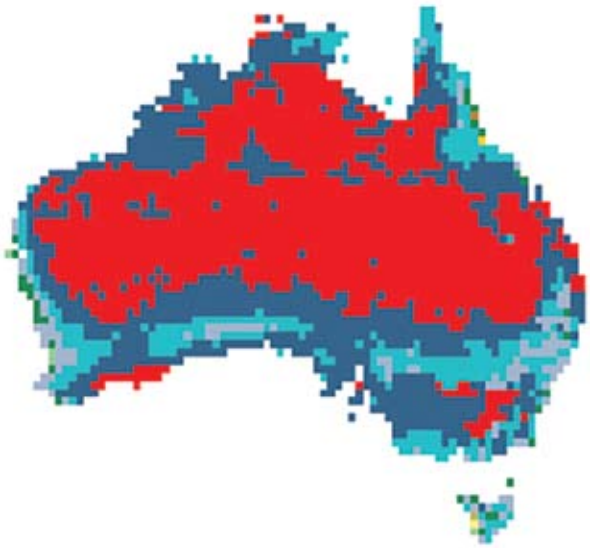

Figure 9. Potential distribution of *Equus caballus* in Australia—red indicates areas where climate is most suitable, decreasing to dark blue, light blue, grey, green, with yellow as the least suitable areas (map prepared by M. Hannan-Jones).

Based purely on an assessment of climate, feral horses are likely to survive over most of Queensland, with Central and Western Queensland most suitable. It is important to note, however, that other habitat requirements—such as the availability of food—will influence range and abundance.

It is difficult to predict if the feral horse population in Queensland will increase in the future. On the one hand, the population has been expanding for the last 100 years and has probably had sufficient time to reach the land's maximum carrying capacity over parts of its total range. Supporting this hypothesis is the fact that, in some areas at least, the population appears to be fluctuating in response to variable seasonal conditions, primarily rainfall. On the other hand, there seems to be potential for increased abundance in areas such as Carnarvon National Park and perhaps forested areas along eastern and south-eastern Queensland, where numbers are still patchy. Hence, the total negative impact of feral horses in Queensland might increase above current levels in favorable years, when widespread rainfall improves recruitment and avoids heavy losses caused by drought. Local increases in impact seem most likely in forested areas in central, eastern and south-eastern Queensland.

Legislative restrictions

Feral horses are not 'declared' pest animals in Queensland, as defined by the *Queensland Land Protection (Pest and Stock Route Management) Act* 2002.

In New South Wales, feral horses are listed as 'Category 4 non-indigenous animals' under the Non-Indigenous Animals Regulation 2006. A Category 4 animal is 'a species that would be unlikely to present a threat or greatly worsen an existing threat if they escaped into the wild' (New South Wales State Government, 2006).

In the ACT, feral horses are not listed as 'pest animals' under the *Pest Plants and Animals Act 2005*, as they are restricted to Namadgi National Park and are not established across a range of land tenures. A feral horse management plan is in place to deal with feral horse problems in the ACT (Department of Territory and Municipal Services, 2005).

In Victoria, feral horses are not formally recognised as pests under the *Catchment and Land Protection Act 1994*. However, other pieces of legislation allow some provision for enforced control and management (Dawson et al. 2006).

In South Australia, feral horses are a 'declared species' under the *Natural Resources Management Act 2004*. However, there is no statutory requirement for land managers to control them (Dawson et al. 2006).

In Western Australia, feral horses are 'declared animals' under the *Agriculture and Related Resources Protection Act 1976* when running wild in agricultural and pastoral areas. They are listed as 'Category A5 animals', which means landholders are required to reduce or control numbers (Dawson et al. 2006).

In the Northern Territory, feral horses are listed as 'feral animals' under the *Territory Parks and Wildlife Conservation Act 2001* (Northern Territory Government, 2007).

Control

While there are a range of effective options available to manage feral horse populations, destruction of feral horses is often a complex and contentious issue. Many people believe feral horses are iconic and culturally significant. Hence, there is often public outcry in response to lethal control programs (Nimmo and Miller, 2007). When considering control options, it is important to consider not only practical aspects, such as landscape topography and the number of horses, but also public opinion. Control methods include aerial shooting from helicopters, ground shooting, mustering/trapping, immobilisation and fertility control (Nimmo and Miller, 2007).

For a comprehensive review of feral horse management refer to Dobbie et al. (1993).

Numerical risk assessment using the ‘Bomford assessment’

A numerical risk assessment system published by Bomford (2008) is accepted as the national standard for assessing the level of risk posed by non-indigenous vertebrate species. This approach enables numerical ranking and prioritisation of large numbers of species. First, a species’ potential distribution is predicted using climate-modelling computer programs. The remaining steps involve allocation of scores for a number of attributes relevant to a species’ pest status, including biology, costs to the economy, the environment and society, and management efficacy.

Using the Bomford system, horses were assessed as an ‘extreme’ threat to Queensland (refer to attachment).

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Attachment

Using the Bomford (2008) system, feral horses in Queensland were ranked as an 'extreme' threat species.

Species:		***Equus caballus* (feral horse)**
Date of assessment:		16.04.2009
Literature search type and date:		see references
Factor	**Score**	
A1. Risk to people from individual escapees (0–2)	1	Horses are capable of causing serious injury or fatality if cornered or handled.
A2. Risk to public safety from individual captive animals (0–2)	0	Nil risk of irresponsible use of products obtained from horses posing a public safety risk.
Stage A. Public safety risk rank = Sum of A 1 to 2. (0–4)	**1**	**Moderately dangerous**
B1. Climate match (1–6)	6	Extreme climate match in Australia. CMS = 88 206.
B2. Exotic population established overseas (0–4)	4	Feral horse populations have established in Australia, New Zealand, United States, France, Greece, Portugal, Spain, Sri Lanka, Iran, West Indies, Colombia, Hawaii, Galapagos and other oceanic islands.
B3. Overseas range size (0–2)	1	Overseas range size of 19 million square kilometres (Feral.org.au, undated).
B4. Taxonomic class (0–1)	1	Mammal.
B5. Diet (0–1)	1	Generalist diet includes: mainly grasses, but they will eat emergent and sub-emergent plants in swampy areas. They also eat roots, bark, buds and fruit—capable of walking long distances to locate the most palatable feed.
B6. Habitat (0–1)	1	Feral horses can live in human-disturbed habitat including grazing and agricultural lands.
B7. Migratory (0–1)	1	Non-migratory.
B. Probability escaped or released individuals will establish a free-living population = Sum of B 1 to 7. (1–16)	**15**	**Extreme establishment risk**
C1. Taxonomic group (0–4)	2	Perissodactyla
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2)	1	Overseas range size of 19 million square kilometres (Feral.org.au, undated).
C3. Diet and feeding (0–3)	3	Mammal that is primarily a browser.
C4. Competition with native fauna for tree hollows (0–2)	0	Does not use tree hollows.
C5. Overseas environmental pest status (0–3)	1	Minor environmental pest overseas.

Species:		***Equus caballus* (feral horse)**
C6. Climate match to areas with susceptible native species or communities (0–5)	5	The species has more than 20 grid squares within the highest two climate match classes, and has more than 100 grid squares within the four highest climate match classes, that overlap the distribution of any susceptible native species or communities.
C7. Overseas primary production pest status (0–3)	1	Feral horses are a minor threat to cattle and pastures overseas.
C8. Climate match to susceptible primary production (0–5)	5	Total commodity damage score = 210 (see Table 1).
C9. Spread disease (1–2)	2	Mammal
C10. Harm to property (0–3)	1	$1–10 million—damage to infrastructure (i.e. fences, watering points etc reported as $800–$1000 per property per year).
C11. Harm to people (0–5)	3	Main concern with feral horses is their potential to cause road accidents where they are living along unfenced busy highways. Aggressive stallions may also attack bushwalkers.
C. Probability an exotic species would become a pest (for birds, mammals, reptiles and amphibians) = Sum of C 1 to 11. (1–37)	**24**	**Extreme pest risk**
A. Risk to public safety posed by captive or released individuals		
A = 0 = not dangerous A = 1 = moderately dangerous A ≥ 2 = highly dangerous	1	Moderately dangerous
B. Risk of establishing a wild population		
For birds and mammals: B ‹ 6 = low establishment risk B = 7–11 = moderate establishment risk B = 12–13 = serious establishment risk B › 14 = extreme establishment risk	**15**	**Extreme establishment risk**
For reptiles and amphibians: B ‹ 3 = low establishment risk B = 3–4 = moderate establishment risk B = 5–6 = high establishment risk B › 6 = extreme establishment risk		
C. Risk of becoming a pest following establishment		
C ‹ 9 = low pest risk C = 9–14 = moderate pest risk C = 15–19 = serious pest risk C › 19 = extreme pest risk	**24**	**Extreme pest risk**
VPC threat category		**Extreme**

Table 1. Calculating Total Commodity Damage Score

Industry	Commodity Value Index[1] (CVI)	Potential Commodity Impact Score (PCIS, 0–3)	Climate Match to Commodity Score (CMCS, 0–5)	Commodity Damage Score (CDS, columns 2 × 3 × 4)
Cattle (includes dairy and beef)	11	2	5	110
Timber (includes native and plantation forests)	10	2	5	100
Cereal grain (includes wheat, barley sorghum etc)	8	0	Not estimated	0
Sheep (includes wool and sheep meat)	5	0	Not estimated	0
Fruit (includes wine grapes)	4	0	Not estimated	0
Vegetables	3	0	Not estimated	0
Poultry and eggs	2	0	Not estimated	0
Aquaculture (includes coastal mariculture)	2	0	Not estimated	0
Oilseeds (includes canola, sunflower etc)	1	0	Not estimated	0
Grain legumes (includes soybeans)	1	0	Not estimated	0
Sugarcane	1	0	Not estimated	0
Cotton	1	0	Not estimated	0
Other crops and horticulture (includes nuts, tobacco and flowers)	1	0	Not estimated	0
Pigs	1	0	Not estimated	0
Other livestock (includes goats, deer, camels, rabbits)	0.5	0	Not estimated	0
Bees (includes honey, beeswax and pollination)	0.5	0	Not estimated	0
Total Commodity Damage Score (TCDS)	—	—	—	**210**