Chapter 8:
Review of non-commercial control methods for feral camels in Australia

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List of shortened forms

ALT	Aboriginal Land Trust
APAS	*Australian Pest Animal Strategy*
APY	Anangu Pitjantjatjara Yankunytjatjara
CAT	Centre for Appropriate Technology
CDEP	Community Development Employment Project
CLC	Central Land Council
FAAST	Feral Animal Aerial Shooter Training
GIS	Geographic Information System
GPS	Global Positioning System
IPA	Indigenous Protected Area
NRM	Natural Resource Management
SLR	Self-loading rifles
SSCAW	Senate Select Committee on Animal Welfare
UKTNP	Uluru–Kata Tjuta National Park
VPC	Vertebrate Pests Committee
VRD	Victoria River District

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Chapter 8: Review of non-commercial control methods for feral camels in Australia

1. Summary

Current management of feral camels falls far short of an integrated management approach, with limited integration of different control methods or across jurisdictions (Edwards et al. 2004, Norris & Low 2005) and, to date, having had little effect on population growth or in mitigating camel impacts.

A range of control methods, both commercial and non-commercial, are available for the management of feral camels, and most have been implemented to some extent. This chapter reviews non-commercial control methods which can be applied to mitigate the negative impacts of feral camels.

To date non-commercial control has primarily consisted of aerial platform (helicopter) shooting, ground-based shooting, and exclusion fencing. Chemical (poison), biological, and fertility controls are not currently in use, although a review undertaken for this project (Lapidge et al. 2008) has identified a number of potential avenues for further consideration.

Of the three non-commercial methods in current use, aerial shooting is the most widely implemented by management agencies. The majority of ground-based shooting is opportunistic in nature and implemented individually by pastoralists rather than by management agencies. Fencing has been limited to a number of waterholes of both cultural and conservation significance in central Australia.

Aerial shooting has been identified as the non-commercial control method with the greatest applicability (Edwards et al. 2004, Norris & Low 2005) to broadscale feral camel management. The cost range reflects the availability of animals at different densities. Although the detailed nature of the cost density relationship is unknown for camels, indicative costs are \$20–\$30 per animal at high density (densities greater than 0.3 animals/km^2); \$40–\$100 per animal for densities in the range 0.3–0.1 animals/km^2; and a cost per animal greater than \$100 for densities less than 0.1 animals/km^2.

The limitations of ground-based shooting compared with aerial shooting include restricted access to animals and reduced ability to remove large quantities of animals. Ground-based shooting has limited applicabilty for broadscale population reduction and will primarily fill a long-term management role of maintaining low density populations through opportunistic shooting integrated with other activities.

The high cost of fencing, particularly for areas greater than a few hectares, and the fact that fencing does not affect population size and growth, greatly limits the applicability of fencing in managing the impacts of feral camels. Fencing is primarily applicable to the protection of high value cultural and conservation assets where the total exclusion of feral camels is mandatory to prevent any damage to the assets. Fencing is not considered a broadscale management tool.

1.1 Recommendations

- That aerial shooting from helicopters is recognised as the optimal control action to achieve large population density reductions over broadscale areas, particularly in short time frames, and the only available control action that can be used in very remote or inaccessible areas.
- That aerial shooting from helicopters be based on specific targets and outcomes and that to achieve this objective, removed and final population densities must be known, requiring pre- and post-control population monitoring.
- That any proposed camel management program, particularly involving aerial shooting, must be fully funded and adequately resourced to meet the proposed outcomes, including all monitoring requirements.

- That it is recognised that effective management of camels and their impacts will involve the integration of all available control methods, both non-commercial and commercial, and that the development of scale-dependent, multiple outcome management plans integrated into the national framework will be key to the effective management of feral camel impacts in Australia.
- That it is recognised that ground-based shooting has limited applicabilty for broadscale population reduction and will primarily fill a long-term management role of maintenance of low density populations through opportunistic shooting integrated with other activities.
- That it is recognised that exclusion fencing is not a broadscale level management tool. Fencing is likely to be most effective when applied at the local scale to protect high value assets.
- That the following techniques are investigated further for the chemical, biological and fertility control of camels:
    - Low concentration delivery of nitrite or 1080 in raised water troughs. This may be made more specific if delivered at salt lakes where fresh water is more desirable for camels and species diversity is lower.
    - Delivery of sodium or potassium nitrite via a camel-specific feeding trough or raised salt lick at natural congregation points. Potassium chloride or 1080 may act synergistically with nitrite, which would lower the dose required and shorten the time to death.
    - A combination of potassium chloride with a diuretic, with and without a nephrotoxic agent such as banamine and phenylbutazone, should be examined further as it may prove uniquely toxic to camels.
    - Camelpox is worthy of further investigation, particularly in reference to its spread in more natural nomadic camel populations within the species range and the humaneness of the virus. Regardless, camelpox is unlikely to be the 'calicivirus' of camels in Australia, and would be principally introduced to limit population recruiment (following Lapidge et al. 2008).
    - An immunocontraceptive vaccine technology that is orally active and has a species-specific immunogen is favoured for fertility control. Research into a feral pig anti-fertility vaccine that can be used as a platform from which to undertake similar research in camelids holds the greatest hope for this in the immediate future but requires funding for extension of the work into camels.
    - Three other novel approaches to manipulating fertility warrant attention: phage panned peptide technology, the Talwar protein, and antigen delivery systems such as bacterial ghosts.

2. Current feral camel management context

Feral camel management is currently carried out in what can only be described as an 'ad hoc' approach (Edwards et al. 2004, Norris & Low 2005), with limited cross-jurisdictional coordination to date (Norris & Low 2005) and having little impact on populations overall (Edwards et al. 2004, Ward 2007).

Based on current distribution and abundance, camels are not considered a major problem in either New South Wales (NSW) or Queensland (Qld) at present, and little or no coordinated government management is being undertaken in these jurisdictions apart from maintenance of the existing dog fence. In Western Australia (WA), South Australia (SA), and the Northern Territory (NT), where camels are recognised as a significant feral animal, there has been a limited amount of government management, primarily aerial surveys to determine distribution and abundance, opportunistic culling programs, commercial harvest, and fencing off of waterholes (Norris & Low 2005). Additionally, pastoral managers across all jurisdictions have undertaken limited control of feral camels on their properties, primarily opportunistic shooting but with some coordinated government actions (Norris & Low 2005, Gee & Greenfield 2007, Zeng & Edwards 2008a).

On the basis that the camel population is doubling every nine years (McLeod & Pople 2008) and a current population estimate of about one million animals (Saalfeld & Edwards 2008), management activities need to remove at least 80 000 animals annually to maintain the current population.

Given that the assessment of current feral camel negative impacts (Edwards, Zeng & Saalfeld 2008) indicates an urgent requirement for reduction of these impacts in certain locations, it is likely that substantially more than the estimated minimum of 80 000 camels will need to be removed annually for a period of years to maintain current population levels if current population densities and resulting impact are to be reduced to acceptable levels.

The current limited market for the commercial utilisation of feral camels (Ellard & Seidel 2000, Warfield & Tume 2000, Edwards et al. 2004, Norris & Low 2005) and the projected lengthy time frame to develop the commercial utilisation market (Zeng & McGregor 2008) means that a substantial requirement for non-commercial control methods for the management of feral camels exists and will continue to exist for some time.

At present, commercial utilisation removes 5000–6000 feral camels annually across the Australian distribution (Zeng & McGregor 2008), leaving a shortfall of a minimum of 75 000 animals needing to be removed annually to maintain current population levels. Available reporting puts the current non-commercial removal at between 10 000 to 20 000 animals annually covering all land tenures (Figures 8.1 & 8.2) resulting in a shortfall of a minimum of 55 000 animals needing to be removed annually to maintain current population levels and potentially substantially more than this to achieve desired management outcomes (Edwards, Zeng & Saalfeld 2008, Drucker 2008). Currently, this shortfall can only be addressed through non-commercial control methods. In the medium to longer-term, commercial utilisation may play an expanded role in the management of feral camels if markets can be expanded (Zeng & McGregor 2008).

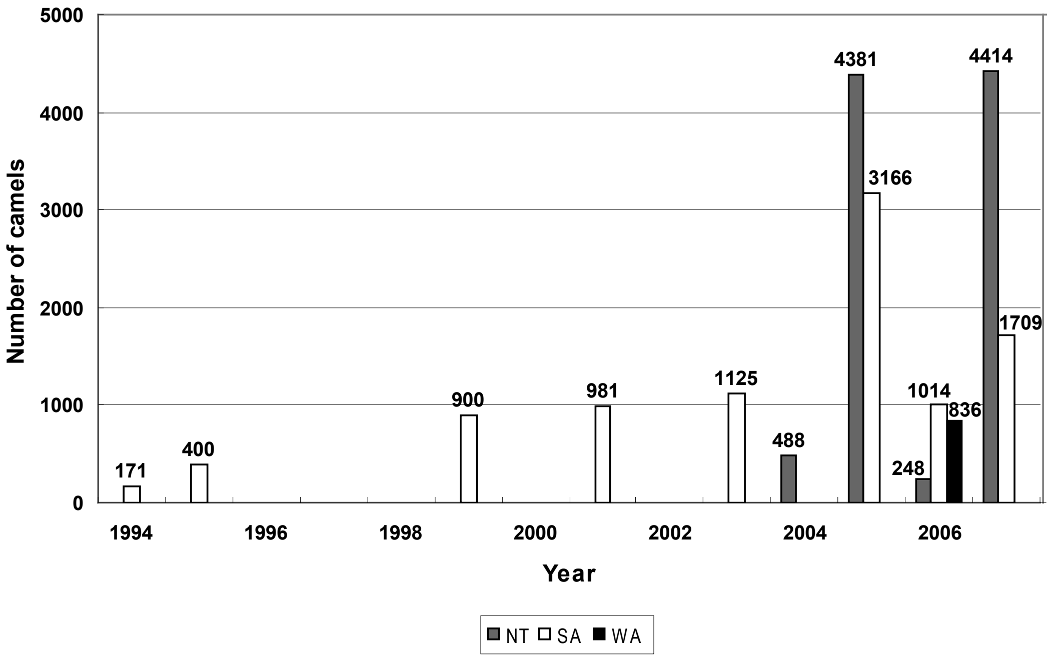

Figure 8.1: Camels removed via non-commercial control in the NT, SA, and WA from available records

Source: (Ward & Burrows 2007, Gee & Greenfield 2007, Oag 2008, S Eldridge 2007, Consultant, Desert Wildlife Services, pers. comm., Kym Schwartzkopff 2007, Wildlife Officer, NRETAS, pers. comm.).

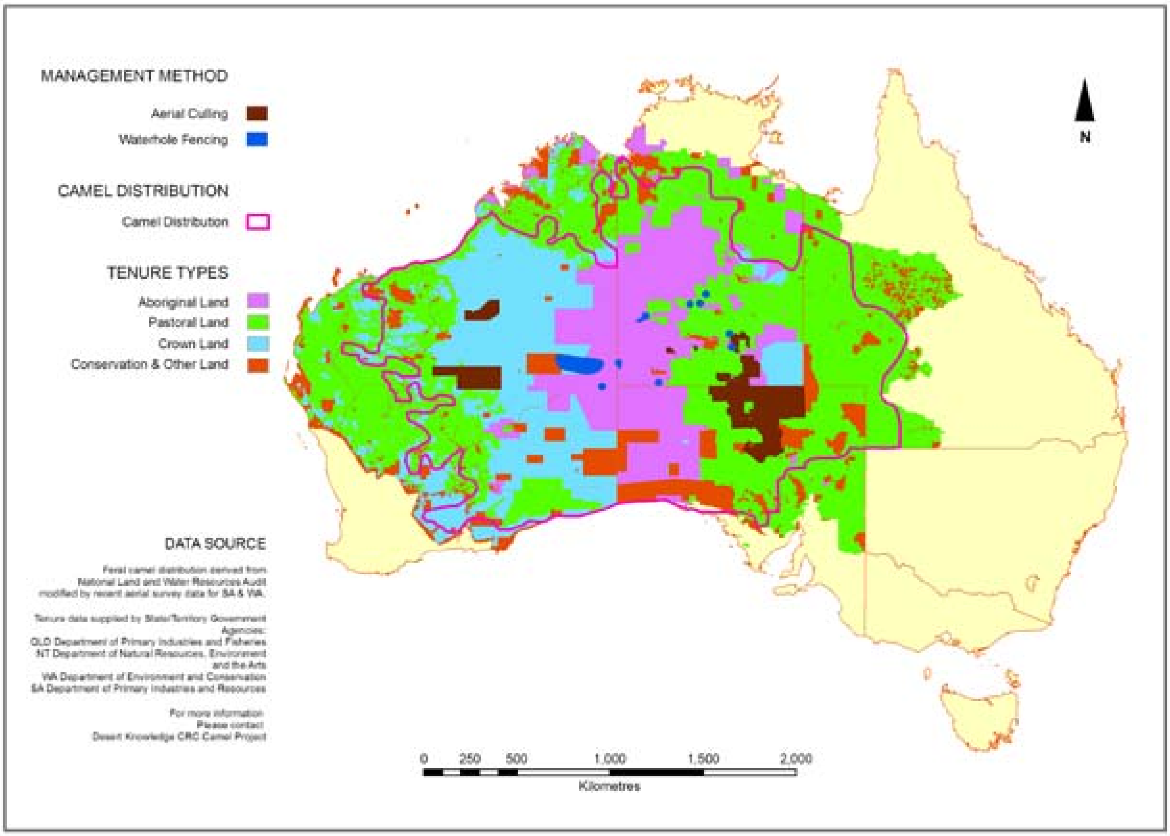

Figure 8.2: Locations of government-managed aerial culling operations and waterhole fencing projects for feral camels since 2001

Gee and Greenfield (2007) state that 72.5% of pastoralists in the South Australian Arid Lands NRM Region opportunistically cull camels on their properties by shooting them from vehicles. Approximately one-third of these properties have reportedly removed more than 100 camels over the last five years (Gee & Greenfield 2007). Pastoralists in both the NT and WA also remove camels through ground-based shooting for non-commercial purposes; however, available records are insufficient to estimate numbers.

In order to meet a minimum management outcome of keeping the current feral camel population stable, a near order-of-magnitude increase in the effort invested in non-commercial control methods is immediately required. This near order-of-magnitude increase in the effort reflects the requirement to increase non-commercial removal from the current level of 10 000 to 20 000 annually to at least 75 000 as determined above. Associated with this would be the requirement for a near order-of-magnitude increase in the level of funds expended on non-commercial control methods.

In this report we review non-commercial control methods which can be applied to mitigate the negative impacts of feral camels.

2.1 Legal status

Primary responsibility for the management of feral animals and the prevention of cruelty to animals lies with individual state and territory governments (SSCAW 1991, Braysher 1993, Dobbie et al. 1993). Individual landholders are responsible for the management of feral animals on their lands, and state and territory governments have the legislative capacity to require landholders to manage feral animals on their lands (Braysher 1993). The Australian Government is responsible for feral animal management on lands it manages, in the scope of animal import and export and exotic disease prevention and control (Braysher 1993, Dobbie et al. 1993).

A detailed review of all Commonwealth, state and territory legislation that has any role in the declaration and management of feral camels in Australia has been undertaken and is reported in Carey, O'Donnell, Ainsworth, Garnett, Haritos, Williams, Edwards, McGregor and Zeng (2008), and in Carey, O'Donnell, Ainsworth, Garnett, Haritos and Williams (2008).

The legislation review (Carey, O'Donnell, Ainsworth, Garnett, Haritos and Williams 2008) clearly identifies a range of Commonwealth and individual state and territory legislation that rigidly regulates all of the potential control methods, either commercial or non-commercial, that may be used in the management of feral camels.

2.2 Collaboration between jurisdictions

Norris and Low (2005) considered that current management of feral camels is largely ad hoc and that a strategic approach had yet to developed and implemented. They define a strategic approach as management which aims to prevent damage rather than dealing with damage that has already occurred (Norris & Low 2005), and state that camels are fast becoming a lost opportunity for strategic control due to rapidly increasing numbers.

Braysher (1993) identifies the core components of a strategic pest management plan as:

- define the problem
- define the objectives, performance criteria, and criteria for failure
- identify and evaluate available management actions
- implement management actions
- monitor and evaluate implementation against objectives.

The need for a strategic approach to the management of all of Australia's vertebrate pest animals, including the feral camel, has been clearly recognised by the Commonwealth and the individual states and territories through the development of the *Australian Pest Animal Strategy* (APAS) (2007).

Developed by the Vertebrate Pests Committee (VPC) of the Natural Resource Management Ministerial Council – an Australasian committee with membership of each state and territory, the Australian Government, New Zealand, CSIRO, and the Invasive Animals CRC – the APAS seeks to address the undesirable economic, environmental, and social impacts of vertebrate animals (*Australian Pest Animal Strategy* 2007). The goals of the APAS and the associated objectives, actions, and outcomes clearly recognise the need for and provide mechanisms to achieve a strategic approach to the management of vertebrate pest animals across Australia. Integral to this, and recognised in objective 1.2 of the APAS 'to ensure nationally consistent pest animal management approaches are in place at all scales of management', is the need for coordination and collaboration between all jurisdictions.

Recognition of the need for collaboration and coordination of feral camel management across both jurisdictions and stakeholder groups was one of the major outcomes of the Feral Camel Action Plan Workshop (Edwards 2005). The recommendations and associated actions and research reported in the workshop outcomes are consistent with the objectives and actions contained within the APAS.

The APAS and the Feral Camel Action Plan Workshop identify a range of actions to achieve collaboration and coordination of pest animal (including camel) management across Australia. Actions include:

- Establish an implementation group to oversee delivery of the *Australian Pest Animal Strategy*. By extension this would require establishing a national group to oversee the development and implementation of feral camel management at the national scale. This requirement has been potentially addressed through the establishment of the Steering Committee for the 'Cross-jurisdictional management of feral camels to protect NRM and cultural values' project.

- Establish the position of Coordinator, *Australian Pest Animal Strategy*. The extension of this to feral camel management would be the establishment of a coordinator for the delivery/implementation of the recommendations of the 'Cross-jurisdictional management of feral camels to protect NRM and cultural values' project. This is consistent with the program for the delivery of national coordination in the Australian Weeds Strategy through the Weeds of National Significance Program, which includes a coordinator for individual weed species.
- Improve the consistency and effectiveness of pest animal management legislation across Australia. A review of all Commonwealth, state and territory legislation that has any role in the declaration and management of feral camels in Australia was undertaken by the 'Cross-jurisdictional management of feral camels to protect NRM and cultural values' project to identify impediments to a coordinated and integrated national approach (Carey, O'Donnell, Ainsworth, Garnett, Haritos, Williams, Edwards, McGregor and Zeng 2008; Carey, O'Donnell, Ainsworth, Garnett, Haritos and Williams 2008).
- Develop integrated pest animal management plans that are consistent with the principals of the APAS at national, state, territory, regional, and property levels. The 'Cross-jurisdictional management of feral camels to protect NRM and cultural values' project will provide a framework and tools to facilitate the management of feral camels and their impacts at a range of scales.
- Develop nationally consistent codes of practice and standard operating procedures for pest animal management. Nationally consistent codes of practice and standard operating procedures have already been developed for a number of vertebrate pest animals (Sharp & Saunders 2004, Australian Government 2004), and will be developed for all vertebrate pest species (APAS 2007), including the feral camel.

Given the significant emphasis placed on the collaboration and coordination of pest animal, including feral camel, management across Australia, implementation of the above actions is clearly a priority in the development and implementation of management programs for feral camels.

2.3 Availability of resources for feral camel management

Holznagel and Saalfeld (2002) and Saalfeld et al. (2006) indentified the greatest limitation on successfully implementing a control program for donkeys and horses in the Victoria River District of the NT as a failure to recognise and plan for adequate resourcing to achieve the programs target outcomes. Inadequate resourcing is almost invariably a consequence of funding limitations. The majority of feral animal management programs are dependent upon federal and state/territory government funding, and this funding is generally sought by government and non-government management agencies in a competitive process for finite funds. Broadscale feral animal management (i.e. that occurring over large areas; typically >10 000 km^2) is invariably extremely expensive, with program costs of hundreds of thousands to millions of dollars annually (Drucker 2008), amounts which can easily exceed total amounts available for feral animal management from funding agencies. In this circumstance programs often have to be reduced to meet funding constraints.

Adequate resourcing to undertake management will be a core requirement of any integrated management program for feral camels in Australia. To address resource requirements, an audit of available resources should be undertaken covering all jurisdictions. This process should allow for the identification of potential critical areas of resource shortfall which could compromise program delivery.

2.4 Current non-commercial control methods

The suite of non-commercial control methods that are potentially available for use in the management of feral camels consists of:

- aerial platform (helicopter) shooting
- ground shooting
- fencing to prevent access
- baiting/poisoning
- biological control
- fertility control.

Of the above methods, only the first three are in current use and are discussed in detail herein. The final three methods are considered in a 'Review of Chemical, Biological and Fertility Control Options for the Camel in Australia', which was undertaken by the Invasive Animals Cooperative Research Centre (Lapidge et al. 2008) and is reported here (section 6.1).

The criteria used to determine which method, or combination of methods, of control are used for a specific management program or management area are highly varied and dependent on a range of factors. This combination of factors used in determining appropriate control methodology is considered in detail in Saalfeld et al. (2008). In summary, the key factors are:

- feral camel density
- land tenure and perceptions/requirements of the landholder
- access to the animals
- access to infrastructure to support control methods
- conservation/natural resource/cultural values impacted by feral camels.

Dobbie et al. (1993), in discussing methods of control for feral horses state, 'No single method is likely to offer effective control' and it is reasonable to expect the same to be true for feral camels.

3. Aerial culling

Aerial platform (helicopter) shooting has long been recognised as the only practical method of controlling a number of large vertebrate feral animals, including camels, across large-scale regions, in inaccessible areas, or to achieve rapid density reductions (SSCAW 1991, Dobbie et al. 1993, Edwards et al. 2004, Norris & Low 2005). Norris and Low (2005) identify aerial shooting from helicopters as 'probably one of the best control techniques for large feral herbivores in the rangelands'.

Significant opposition to the use of aerial platform shooting for control of feral animals exists, particularly among animal welfare organisations worldwide based on perceptions that it is cruel and inhumane (SSCAW 1991, Norris & Low 2005). However, there is a limited recognition by some of these organisations that there are circumstances where aerial platform shooting is the only viable mechanism to achieve control (SSCAW 1991).

This study (Vaarzon-Morel 2008a, 2008b) has indicated that there is widespread and substantial opposition to aerial shooting of feral camels 'to waste' exists in Aboriginal communities across the camels range in Australia. This opposition also encompasses ground-based shooting 'to waste' and derives primarily from the Aboriginal cultural perspective that camels are a part of the environment and hence have both a role to play in the environment and also serve as a resource to be used (Vaarzon-Morel 2008a). It is important to note that Aboriginal people do not oppose the shooting of camels per se; it is the issue of wastefulness that they are mostly concerned with.

At present the criteria used to determine whether on not aerial platform shooting of feral camels is undertaken generally comes down to four factors:

1. whether the landholder(s) wishes to use commercial or non-commercial control methods
2. the accessibility of the animals
3. the density of animals to be controlled
4. the level and speed of density reduction required.

Given the broad distribution of the feral camel across Australia's rangelands, with highly variable density at both the local and the broadscale (Axford et. al 2002, Edwards et al. 2004, Peeters et al. 2005, Lethbridge 2007, Ward 2007), and the wide range of ground accessibility from easily accessible to inaccessible (SSCAW 1991, Edwards et al. 2004), aerial platform (helicopter) shooting of feral camels will undoubtedly play a major role in their management into the foreseeable future.

3.1 Description of methods

Aerial platform (helicopter) shooting involves the use of a helicopter flying at low-level altitude and low velocity to position a marksman relative to the target animals so as to have a clear and unimpeded shot to obtain a humane kill. Both the helicopter pilot and marksman have to have undertaken appropriate specific training and received recognised accreditation before engaging in aerial shooting operations (SSCAW 1991).

A Code of Practice for the control of camels and a Standard Operating Procedure for the aerial platform (helicopter) shooting of feral camels are under development. These documents are expected to closely align with the existing *Model Code of Practice for the Humane Control of Feral Horses* and *Standard Operating Procedure for the Aerial Shooting of Feral Horses* (Sharp & Saunders 2004, Australian Government 2004).

Using the *Standard Operating Procedure for the Aerial Shooting of Feral Horses* as a model, a proposed draft operating procedure has been developed for feral camels and is included in Appendix 8.1.

In addition to using the helicopter as a shooting platform, the use of a single engine, fixed high-wing aircraft (e.g. Cessna 172, 182) as a spotter aircraft to locate groups of animals and direct the helicopter to them is strongly recommended. While this is not essential at high animal densities when groups of animals can be quickly located by the helicopter at low altitude with minimal search time, it can significantly increase operational efficiency at lower animal densities by minimising the search time of the helicopter. The spotter aircraft must operate at sufficient altitude above the operational altitude of the helicopter and with sufficient lateral clearance to ensure safe operations. Pilots of both aircraft should maintain constant radio contact (preferably on a dedicated frequency to ensure clear communications), and should maintain regular visual contact.

3.2 Cost and effectiveness

While helicopter shooting may be the only practical method for the control of feral camels across large-scale regions, in inaccessible areas, or to achieve rapid density reductions, the cost of helicopter shooting is highly variable dependent upon density. When animal densities are high it can be a cost-effective way to quickly reduce animal numbers; however, at lower densities the cost per animal can become prohibitive (Norris & Low 2005).

The cost of two recent aerial control operations for feral camels, one in WA in 2006 (Ward & Burrows 2007) and one in SA and the NT in 2007 (Oag 2008; David Oag 2007, Pastoral Inspector, SA Department of Primary Industries and Resources, pers. comm.; Kym Schwartzkopff 2007, Wildlife Officer, NRETAS, pers. comm.), are presented in Table 8.1. Cost per animal for each of these and other aerial control operations is summarised in Table 8.2. Note that, although these operations were focused on feral camels, other large herbivore pests were also shot where the opportunity arose.

Table 8.1: Total cost for the control of feral camels using helicopter shooting

Helicopter shooting operation (Reference)	Operational component	Component cost $	Component amount	Total cost $
WA 2006 (Ward & Burrows 2007)	Helicopter and aircraft		5 days	45 650
	Other		5 days	33 350
	Total		**5 days**	**79 000**
SA 2007 (Oag 2008, David Oag, pers. comm.)	Helicopter (Robinson R22)	$375/hr (GST inc)	8 hrs/day	3000
	Fuel (Avgas)	$2/ltr (GST inc)	40 ltrs/hr	640
	Ammunition	$0.80/round (GST inc)	3 rounds/animal (250 animals/day)	600
	Marksmen	$300/day	2	600
	Onground support	$300/day		300
	Station accommodation	$80/day (camp allowance)		80
	Aerial support (spotter plane)	$200/hr	8 hrs/day	1600
	Ground support by stations	$100/day		100
			total per day	**6920**
	Oct07		**3 days**	**20 760**
	Nov07		**9 days**	**62 280**
	Total		**12 days**	**83 040**
NT 2007 (Kym Schwartzkopff pers. comm.)	Helicopter (Robinson R44) + 1 marksman		2 days	25 085
	Total		**2 days**	**25 085**

Note: data derived from two recent helicopter shooting operations (Ward & Burrows 2007, Oag 2008).

Table 8.2: Cost per animal for the control of feral camels using helicopter shooting

Helicopter shooting operation (Reference)	Location	No. days	Area (km^2)	Number of animals/number of camels killed	Density reduction (animals/km^2)	Total cost $	Cost per animal/camel $
WA 2006 (Ward & Burrows 2007)	Lorna Glen region	5	13 965	1416/836	0.11	79 000.00	55.79/94.50
SA 2007 (Oag 2008, David Oag pers. comm.)	Simpson Desert	3	29 792	300/300	0.01	20 760.00	69.20/69.20
	Marla Oodnadatta Region	9	52 750	2079/1709	0.03	62 280.00	26.96/36.44
SA 2006 (David Oag 2007 pers. comm.)	Rangelands Action Project	N/A	30 125	1248/1014	0.03	20 624.00	16.53/20.34
SA 2005 (David Oag 2007 pers. comm.)	Rangelands Action Project	N/A	50 574	3553/3166	0.06	59 700.00	16.80/18.86
SA 2001 (David Oag 2007 pers. comm.)	Rangelands Action Project	N/A	77 805	2096/981	0.01	71 864.00	34.29/73.26
NT 2007 (Kym Schwartzkopff 2007 pers. comm.)	Haasts Bluff	1	1798	483/483	0.27	7355.77	15.23/15.23
	Loves Creek	<1	3670	440/111	0.03	10 788.00	24.52/97.19
	Loves Creek	<1	3670	566/310	0.08	8523.60	15.06/27.50
	Lilla Creek, New Crown, Andado	2	19 905	394/258	0.06	9400.40	23.86/36.44
				862/862		15 685.00	18.20/18.20

Note: data derived from two recent helicopter shooting operations (Ward & Burrows 2007, Oag 2008) plus available records from earlier shoots (David Oag 2007, Pastoral Inspector, SA Department of Primary Industries and Resources, pers. comm. and Kym Schwartzkopff 2007, Wildlife Officer, NRETAS, pers. comm.)

On the basis of the information contained in Table 8.2, helicopter shooting costs per animal range from $15.06 up to $69.20, and costs per animal for camels alone range from $15.23 up to $97.19. Except for the 2006 shoot in WA, essential data that are lacking from this cost estimate analysis are the starting population and/or density for each of the areas covered and hence the actual proportional reduction in density achieved. It is well established that the relationship between cost per animal killed and animal density is not linear (Choquenot 1988a, Boulton & Freeland 1991, Dobbie et al. 1993) for large vertebrate feral animals; the relationship is usually an exponential decline in the cost of removal with increasing density, but the actual form is unknown for feral camels. The above data are inadequate to determine this relationship for feral camels.

Dobbie et al. (1993) estimated the cost per head for feral horse control in 1987 and concluded that the values were consistent with those obtained for donkeys by Choquenot (1988a). The values Dobbie et al. (1993) estimated are presented here (Figure 8.3) and converted to 2007 dollars using Consumer Price Index extrapolation ($\$_n = \$_{n-t} * (CPI_n / CPI_{n-t})$ where $\$_n$ = current value, $\$_{n-t}$ = previous value, CPI_n = current CPI value and CPI_{n-t} = previous CPI value).

From Tables 8.2 and Figure 8.3 it is apparent that, on the basis of past helicopter shooting operations for feral camel control, management agencies have been prepared to spend in the range of $15–$100 per animal for control. The relationship between costs of control and density for feral horses (Figure 8.3) suggests camel densities were > 0.3 animals/km^2 for as much as 50% of aerial shooting operations documented in Table 8.2 and between 0.1 and 0.3 animals/km^2 for the remainder. This supports the proposition that management agencies have not been prepared to fund broadscale aerial shooting at densities < 0.1 animals/km^2. At these densities, where cost per head increases substantially (Choquenot 1988a), it would appear that most management agencies do not consider broadscale aerial shooting cost effective. Given the lack of any clear density impact relationship for feral camels prior to this study, this can only be categorised as a simple economic decision rather than a cost/benefit determination.

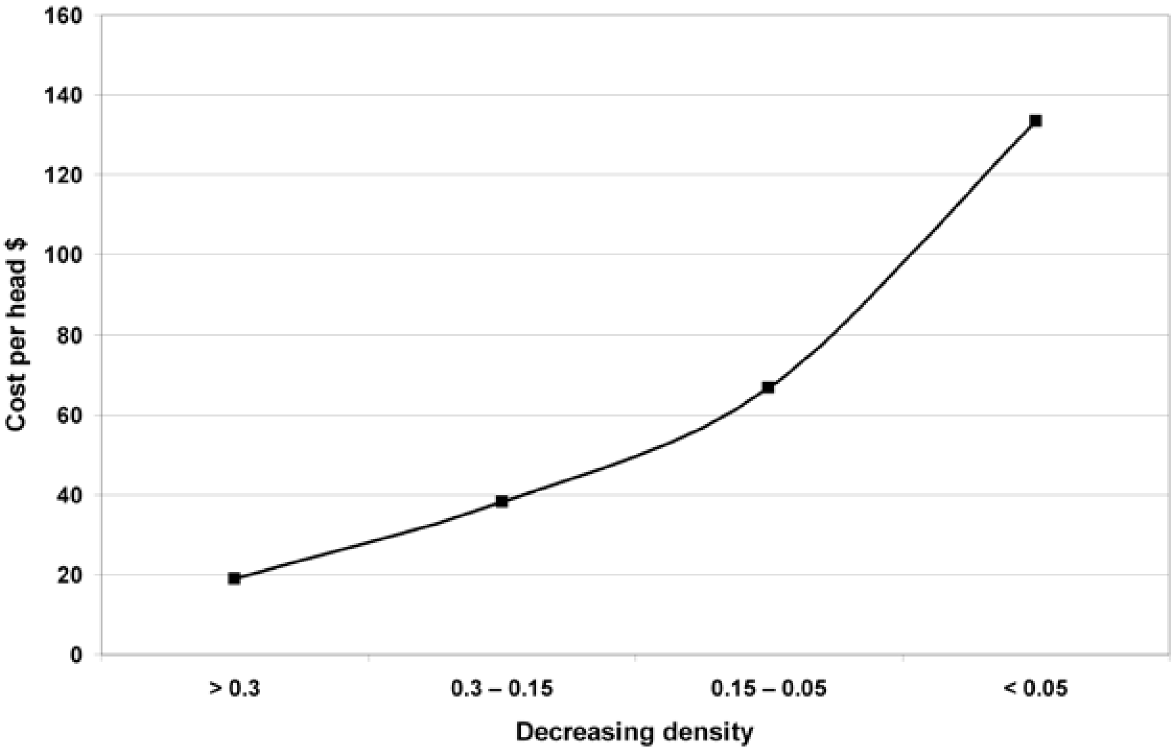

Figure 8.3: Cost per head for helicopter shooting of feral horses showing increasing costs at decreasing densities

Source: Dobbie et al. 1993 converted to 2007 dollar values (CPI_{1987} = 82.6, CPI_{2007} = 157.5)

The major determinant of the minimum cost per animal is the maximum number of animals that can be killed from a single helicopter in one day of operation. Available information (David Oag 2007, Pastoral Inspector, SA Department of Primary Industries and Resources, pers. comm., Kym Schwartzkopff 2007, Wildlife Officer, NRETAS, pers. comm.) suggests that the maximum number of animals that can be killed from a single helicopter in one day of operation is 500–750, depending on density and distribution. Taking into account daily operational costs (Table 8.2) gives an absolute minimum cost per head of $9.23–$13.84.

The actual effectiveness of aerial shooting in managing populations of feral animals across large areas is surprisingly poorly documented. Population reductions of up to 50% in areas of control by aerial shooting have been reported for a number of broadscale aerial control operations (Choquenot 1988b, Saalfeld 2002, Ward & Burrows 2007). However, little or no reporting of the actual impact of these population reductions on conservation or production values has occurred. Additionally, for a number of these population reductions achieved through a broadscale aerial shooting program, a failure to implement ongoing management has resulted in rapid population recovery to pre-control levels (Choquenot 1988b, Saalfeld 2002, Ward & Burrows 2007).

A measure of the effectiveness of broadscale aerial control (helicopter shooting) of feral animals is provided by the NT management of donkeys and horses throughout the Victoria River District (VRD) of the NT (Saalfeld 2002, Holznagel & Saalfeld 2002). The program was implemented in 1999 and covered an area of 120 000 km^2. At that time the donkey population was estimated at 93 000 ± 12 000 animals and management was to be achieved through the declaration of a feral animal control zone covering the area and the issuing of notices to landholders requiring them to remove specific numbers of animals (to achieve an overall density of approximately 0.25 animals/km^2). Control notices totalled 58 000 animals to be removed over a period of three years. In 2001, an aerial survey of the control area gave a population estimate of 103 000 donkeys, while at the same time 58 000 donkeys had been removed (primarily by helicopter shooting) between 1999 and the end of 2001; the removal of 58 000 donkeys over the three-year period had seen an approximate 10% increase in the commencement population. That is, despite the removal of more than 60% of the estimated 1999 population between 1999 and 2001, the population in 2001 was still 10% more than it had been in 1999 (Saalfeld 2002, Holznagel & Saalfeld 2002). This was because allowing three years to achieve the required removal had not taken into account annual recruitment of donkeys (estimated at 25% per annum), and the removal required in the control notices needed to be accomplished in the first year to achieve the target outcome of a reduction in density to 0.25 animals/km^2 (Saalfeld 2002, Holznagel & Saalfeld 2002).

The VRD program is ongoing and it was estimated that 140 000 donkeys had been removed by the end of 2005, for an actual total population reduction of 40 000 donkeys on the 1999 population estimate (Saalfeld et al. 2007). While this program does not appear very successful in terms of efficaciously meeting population reduction targets, the program was highly successful in other areas. It was the first NT Government feral animal program funded primarily by landholders; there was, and is, strong landholder ownership and commitment to ongoing management; and the program was integrated across land tenures. Another strength of the program was that it was subject to internal review, which identified key failings of inadequate resources, lack of compliance, and lack of initial commitment to the program, which were subsequently addressed (Saalfeld et al. 2006). The single most important resource inadequacy was a lack of appropriately qualified and licensed marksmen to undertake aerial shooting operations, followed by lack of aircraft, and lack of qualified pilots (Holznagel & Saalfeld 2002).

For camels, the aerial shooting program most closely approximating the VRD program above has been the SA annual cull of camels associated with the Rangelands Action Project. This cull has taken place annually since 2005 (Table 8.2, David Oag 2007, Pastoral Inspector, SA Department of Primary Industries and Resources, pers. comm.), but has limited facility for comparison with the VRD project to determine efficiency, as the SA cull is not undertaken on the basis of known commencement densities, required off-take, and known target densities. While it does provide details of cost per head for aerial shooting of camels, the value of this information is limited since camel densities are unknown.

3.3 Summary

Aerial platform (helicopter) shooting will almost certainly be the most extensively used method of control for camel management in the immediate future. Aerial shooting is the only method of control that has the capacity to provide access to feral camels across much of the range of the camel in Australia (Saalfeld et al. 2008), subject to a range of non-logistical constraints including landholder and public acceptance (Zeng & Edwards 2008a, Zeng & Edwards 2008b, Vaarzon-Morel 2008a). Further, aerial shooting is the only method of control that is capable of achieving a rapid reduction in feral camel density across a large area.

Although the detailed nature of the cost density relationship is unknown for camels, indicative costs are \$20–\$30 per animal at high density (densities greater than 0.3 animals/km2); \$40–\$100 per animal for densities in the range 0.3–0.1 animals/km2; and a cost per animal greater than \$100 for densities less than 0.1 animals/km2.

While the cost per head for aerial shooting is greater than that for other methods of control and increases substantially as density decreases, the efficacy of this method of control for broadscale management of feral camels guarantees its ongoing role in the management of feral camels in Australia.

The VRD donkey and horse control program (Holznagel & Saalfeld 2002, Saalfeld et al. 2006) has clearly highlighted under-resourcing as the greatest impediment to the successful implementation of a broadscale aerial shooting program, with the most important resource shortfall identified being appropriately qualified and licensed marksmen to undertake aerial shooting operations, followed by lack of aircraft and qualified pilots. Ensuring that adequate resources are available and committed to any aerial control program is probably the single most important factor in achieving the program's target outcomes, and to this end, it is essential to plan aerial control programs as one component of an integrated management approach for feral camels across their range.

4. Ground shooting

As with aerial shooting, ground shooting of feral camels has been carried out across the camel's distribution, but has generally been uncoordinated between landholders or across tenure types and has been carried out opportunistically rather than as planned management.

Ground shooting can be time consuming and labour intensive (Norris & Low 2005), is impractical in rugged or relatively inaccessible terrain (Dobbie et al. 1993, Norris & Low 2005), and injured animals cannot be easily followed to ensure a humane death (Dobbie et al. 1993, Norris & Low 2005). It appears to be optimal when assets of value need protecting (Norris & Low 2005) and where the area of operation is easily accessible, clearly defined, and able to be covered effectively on the ground.

Ground shooting is carried out primarily by pastoral landholders in an opportunistic manner incorporated into other pastoral property activities such as fence line and bore inspection activities. Recreational hunting for feral animals is commonly undertaken on private lands with the blessing of the landholder (Norris & Low 2005). However, the distribution of feral camels in arid rangelands on primarily public (government managed), pastoral, and Aboriginal lands results in little recreational shooting of feral camels. As with aerial shooting 'to waste', Aboriginal communities are generally opposed to ground shooting 'to waste' (Vaarzon-Morel 2008a). As such, recreational ground shooting is generally not condoned on Aboriginal lands, but ground shooting for pet meating is sanctioned on some communities as it is non-wasteful (Zeng & McGregor 2008). Recreational shooting is not permitted on public (government managed) lands in the NT, WA or SA (Carey, O'Donnell, Ainsworth, Garnett, Haritos, Williams, Edwards, McGregor and Zeng 2008) and pastoral enterprises generally prefer to carry out shooting operations under their own management to control access. Ground shooting on public lands is carried out almost exclusively by government officers, particularly on parks and reserves.

Ground shooting of feral camels has occurred in SA, WA, and the NT. However, records of numbers of animals removed through ground-based activities are extremely poor. As previously reported, Gee & Greenfield (2007) provided an estimate of opportunistic culling by pastoralists in the SA Arid Lands NRM Region. Similarly, Ward et al. (2005) reported that culling of camels by pastoralists for sale to the pet meat industry was prevalent in the pastoral area in WA covered by the 2005 survey, but that record keeping was highly variable, ranging from no records to meticulous data (Ward et al. 2005). In the NT, Mulga Park and Curtin Springs stations shot to waste approximately 4500 camels (using ground-based shooters) during the 2006–07 summer and the months that followed following an influx of camels from neighbouring lands (Edwards, Zeng & Saalfeld 2008).

4.1 Description of methods

Ground shooting of large vertebrate feral animals generally involves the shooting of the target animal from a stationary vehicle by a marksman. While there are generally no legislative requirements governing the skill or capabilities of the marksman other than the requirements of the appropriate jurisdiction's Firearms and Animal Welfare legislation, Model Codes of Practice for Humane Control and Standard Operating Procedures for ground-based shooting have been prepared for a number of species (Sharp & Saunders 2004, Australian Government 2004) and should be followed. Any government-managed program will require that all appropriate Codes of Practice and Standard Operating Procedures are followed for all management activities.

A Code of Practice for the control of camels and a Standard Operating Procedure for the ground shooting of feral camels are under development. These documents are expected to closely align with the existing *Model Code of Practice for the Humane Control of Feral Horses* and *Standard Operating Procedure for the Ground Shooting of Feral Horses* (Sharp & Saunders 2004, Australian Government 2004).

Using the *Standard Operating Procedure for the Ground Shooting of Feral Horses* as a model, a proposed draft operating procedure has been developed for feral camels and is included in Appendix 8.2.

4.2 Cost and effectiveness

Almost all non-commercial ground shooting of camels occurring currently is carried out by pastoralists and is opportunistic in nature and directly associated with other property management activities. In this circumstance, estimation of the cost of control is difficult and to some extent irrelevant to the control taking place (but see Edwards, Zeng & Saalfeld 2008). Data are available for commercial ground-shooting operations (Zeng & McGregor 2008) and are used here as the basis to extrapolate cost and effectiveness of non-commercial ground shooting of feral camels.

Best available estimates for ground shooting indicate that daily harvest rates of up 100 animals per day per shooter are achievable when densities are high (P. Duffield, Conservation and Pest Management, Sporting Shooters Association of Australia, pers. comm.). On this basis and using cost estimates associated with commercial (pet meat) operations (Zeng & McGregor 2008), a cost per animal of $7.20 is estimated (100 animals per day per shooter/$440 per day per shooter/$120 per day per vehicle/$1.60 per animal ammunition). While this compares favourably with the cost per animal of aerial control (estimated at around $20–$30 per head at densities greater than 0.3 animals/km^2), the limitations of ground shooting (access and volume) severely restrict the applicability of any broadscale ground shooting program.

4.3 Summary

Ground shooting for non-commercial purposes is of limited applicability in managing the impacts of feral camels when compared with aerial platform (helicopter) shooting. Best estimates (above) give ground shooting only one-fifth the capacity of aerial shooting in areas where both can be undertaken. A consequence of taking five times as long to achieve the same result means that recruitment has a major impact on the capacity to achieve population targets in acceptable timeframes with ground shooting. Opportunistic ground shooting by pastoralists appears to be the most viable application for this method of control, and in this context ground shooting is most likely to play a role in long-term management of feral camel populations once high density populations have been reduced by other control methods.

5. Physical barriers

Fencing has been the most common method used to exclude feral animals from an area (Norris & Low 2005), with the best known fence being the dingo fence, stretching 5614 kilometres and covering three states (Qld, NSW, and SA) to separate southern and eastern sheep grazing lands from cattle and dingo country (Norris & Low 2005).

A number of different types of fence have been used to purposely exclude feral herbivores: conventional stock fencing, electric fencing, and purpose-built fences (Norris & Low 2005). Fences are typically used to break up areas into manageable blocks for control (similar to paddocks used for herd management on pastoral land), to exclude animals from water points, and to protect important areas. Exclusion fencing is being increasingly used to protect areas of high conservation value or to create refuges for native fauna (Norris & Low 2005). Sites of important cultural significance for Aboriginal people that are negatively affected by feral animals, including feral camels, may be best protected by exclusion fencing to prevent any access by feral animals, particularly where the density of animals required to have an impact is unknown.

Exclusion fencing to prevent feral camels accessing important cultural sites on Aboriginal land, primarily important waterholes, has been used in SA, WA, and NT (Figure 8.2).

Northern Territory

Katiti ALT

A program to protect two culturally important rockholes on the Katiti Aboriginal Land Trust (ALT) from camels – Kulpitjata and Putji – began in the late 1990s or early 2000s. These fences were built by A<u>n</u>angu rangers from Ulu<u>r</u>u–Kata Tju<u>t</u>a National Park (UKTNP) for the purpose of excluding camels. They were constructed from heavy duty cable wire with bore casing for posts. Although the fence at Kulpitjata was completed, it was destroyed by camels not long after and is now sitting in a state of disrepair. The Putji fence may still be intact.

The Central Land Council (CLC) has submitted an application for Indigenous Protected Area (IPA) project money with the long-term aim of IPA declaration for the Petermann and Katiti land trusts. If successful, the initial focus of the project will be protection of culturally significant rockholes, springs, and waterholes on these land trusts. This will likely include further work at Kulpitjata, as well as at new sites, such as other culturally important sites that are being heavily affected by camels.

Santa Teresa

The CLC received a Community Water Grant in 2006 to fence three culturally and biologically important springs – Hayes, Salt, and Brumby Springs – in the Allambarinja Range on the Santa Teresa ALT. The fence at Hayes Springs was completed in mid-2006 and work commenced on fencing Salt Springs in November, and was completed by the end of 2007. Camel-proof fencing, designed by the Centre for Appropriate Technology in collaboration with Greening Australia, was erected at these sites. The design includes the use of bore casing as posts and heavy duty wire cable. This is a collaborative project involving CLC Land Management, Greening Australia, and Traditional Owners, and employs CDEP workers from Santa Teresa. Water quality and macro-invertebrate monitoring is being established by NT Department of Natural Resources, Environment, The Arts and Sport at two of the springs with the involvement of older children from Ltyentye Apurte School.

There have been problems with cattle and camels putting pressure on the fence before the summer rains. There has been no alternative water source provided for the camels, cattle, and horses in this area of the land trust so it is likely that the pressure on the fence will continue. Impacts will likely increase at other springs in the area that are not going to be fenced as part of this program.

Nyirripi

Nyirrpi community also received Community Water Grant funding in 2006, assisted by Greening Australia. It is aiming to fence up to 16 rockholes, gnamma holes[1] and springs on the Lake Mackay and Yunkanjini ALTs, prioritised according to their cultural significance. Work commenced on this project in 2007 when permit clearance was been gained from the CLC. Camel-proof fences or 'spider' structures (see below) will be erected at these sites, depending on the most suitable method.

Docker River

An initial project in 2003/04 involved CLC Land Management and senior men covering rockholes with heavy-duty mesh attached to mulga logs as weights. Docker River Council then gained funding in 2005 from the Community Heritage Grants program for further rockhole protection work. CLC contributed a vehicle and a project officer to coordinate the program, while the community paid for materials and wages for A<u>n</u>angu participants out of the grant. Four senior men and up to 11 young men were involved in the work. Three rockholes/soaks to the south of Docker River and one to the east were fenced off using steel rail fence (stockyard fencing) concreted into the ground.

Ahakeye ALT

Community Water Grant funding was received by Charles Darwin University and Greening Australia in 2006 to fence off Anningie waterhole on the Ahakeye ALT. Fencing of this site commenced in 2007.

Pastoral country

Greening Australia has received funding to fence off Mudhut Swamp on Stirling pastoral lease and Spring Creek on Coniston pastoral lease in collaboration with lessees of these stations. While the primary purpose of these fences is to exclude cattle, camels also occur on both stations. The option exists to add an electric line to the fences if camels prove to be a problem. This is also the case for Yaninji Rockhole on the section of Ahakeye ALT that is managed as a grazing lease.

Greening Australia and the manager of the Garden pastoral lease are also planning to fence off a number of springs in Mordor Pound, though they have not yet applied for funding for this project. These springs are being affected by cattle, camels, and other feral animals.

1 Holes made by Aboriginal people for the collection of water.

Western Australia

Wanarn and Patjarr

Ngaanyatjarra Land Management received a small grant in 2004 for Patjarr Community to design and produce 'spider' structures (see below) to protect rockholes from camels. These structures were placed over three rockholes at Tikatika, a site near the community. Further funding was then acquired for both Wanarn and Patjarr communities to construct more spiders. However, all of the construction was undertaken in Wanarn because it happened to have a community project officer who could supervise the welding. A further 15 spiders were placed over rockholes during 2006, between the Gibson Desert Nature Reserve and the Rawlinson Range. Two or three rockholes in the vicinity of Patjarr community were covered by wire mesh held down by rocks prior to the invention of the Patjarr Spider.

Warakurna

Two rockholes in the vicinity of Warakurna have been covered by structures that apparently have successfully kept camels out, while still enabling wildlife to drink. Both are heavy-duty wire mesh structures raised 0.6–0.9 m off the ground. One was constructed by Bureau of Meterology staff and the other by the Warakurna school.

Blackstone

A 100 m x 100 m steel rail fence was erected around an important waterhole to the south of Blackstone community.

Punmu and Parnngurr

Community members have expressed an interest in fencing off a number of significant springs and rockholes in the vicinity of Punmu and Parnngurr communities in the Great Sandy Desert. Camels occur in high densities in this region and many important waterholes and springs are being heavily affected. It is possible that an application for a Community Water Grant will be submitted by the WA Rangelands NRM Coordinator to fund the fencing. Martu traditional owners have also expressed concern about camel impacts in other parts of their country, in particular in the Percival Lakes to the north of Punmu.

South Australia

A<u>n</u>angu Pitjantjatjara Yankunytjatjara (APY) Lands

APY Land Management has been fencing off important rockholes and waterholes from camels over the past few years. They have found that fencing waterholes only serves to increase the pressure on unfenced sites nearby. Their new strategy involves re-commissioning old bores on the Lands to provide an alternative water supply to the rockholes and waterholes. Their evidence suggests that camels prefer to drink from troughs and where these are provided little or no damage occurs to waterholes nearby. They still plan to fence off a certain number of significant sites that are particularly significant and/or vulnerable to camel impacts.

Appropriate use of fencing may help conserve areas of high conservation or cultural value by excluding the feral animals (Norris & Low 2005) and can also provide opportunity and time for other actions (Pickard 2006). However, while fencing can effectively exclude feral camels, it does not necessarily reduce their population number or even their impacts. Fencing simply shifts the point of impact to other, presumably less important, areas. In some instances, an asset enclosed by a poorly designed fence may still be affected by camels. For example, a rockhole enclosed by a poorly situated fence can still become silted up through sediment mobilisation as a result of camels congregating at the barrier fence knowing that there is water nearby. All things considered, fencing is best considered as a strategic small-scale management tool to protect valuable assets.

5.1 Description of methods

A number of designs for exclusion fencing for camels have been developed. Dörges and Heucke (1995, 2003) claimed success with a design based on modified cattle fencing, and the Centre for Appropriate Technology in collaboration with Greening Australia have designed a camel-exclusion fence using substantially heavier and more robust materials than used in stock fencing (Barker & Elliat 2007). A third design involves the use of 'spider' structures, where the waterhole is covered by a structure to prevent the camels being able to enter the waterhole but still giving them access to the water to drink.

The design by Dörges and Heucke (1995, 2003) involved a standard cattle fence (three line barbed wire) extended to a height of at least 1.6 metres with the addition of a fourth top wire. The top wire is made visible by adding light reflecting objects that hang on short lengths of plain wire (5–15 cm) tied to the top barbed wire, with the objects able to swing freely below. Dörges and Heucke (1995, 2003) found empty beer cans were very effective in the role of reflecting object, being both visible and, on windy days, audible. On the basis of these findings, any highly reflective, light weight metallic object in the size range of a standard beer can would make a suitable reflecting object for this fence design. While this fence is reported to be more effective than a standard cattle fence at controlling or managing camel movement, it is unlikely to be any stronger than a standard cattle fence at resisting damage from camels that attempt to penetrate or become entangled in the fence, hence the requirement for inspection and maintenance is likely to be as high as for standard cattle fencing.

The more robust design by the Centre for Appropriate Technology is fully detailed in the Centre's *Bush Tech* #35 publication (Barker & Elliat 2007). The design is intended to protect waterholes and is based on a solid cable fence capable of keeping camels out but allowing native wildlife access. The design is considerably heavier than standard cattle fencing, using bore casing for posts (100 mm diameter and a minimum 3 mm wall thickness) and 8 mm galvanised cable. The fence is designed to be resistant to damage from camels attempting to penetrate it and hence requires less maintenance than standard cattle fencing, but it does need periodic inspection for any damage that may result from very high continual pressure.

As reported above, the 'spider' design has been trialled at a number of locations. The design consists of a central hub, typically an old wheel rim, with eight legs attached to brackets welded to the hub. The legs can be chained for cross-bracing and tin sheeting can be added to reduce evaporation from the waterhole. The design is reported in *The Camel Book* (Tangentyere Landcare 2006) and, as stated, is intended to prevent camels entering the waterhole and becoming trapped and dying therein. It is not designed to stop the camels drinking at the waterhole and does not limit access to the immediate area of the waterhole. Hence this design is not suitable where the objective is to prevent camels from accessing the area of the waterhole and its surrounds.

Bertram et al. (2007) consider a number of fence designs for the management of camel movement. They report that camels are observant, easily taught, and have good memories (Bertram et al. 2007), and that for a fence to become an effective deterrent to camel movement it should be constructed so that it is easily seen and remembered. Bertram et al. (2007) advise that the use of barbed wire should be limited, since the reaction by camels to the adverse stimulus of barbed wire is often the opposite of what is desired – they jump further forward into the fence rather than move away from it. In addition to the design of Dörges and Heucke (1995, 2003) they describe the use of both electric fences and cable fences.

Electric fence designs considered by Bertram et al. (2007) included custom-built electric fences or modification of an existing fence. They advise that the use of electric wires can increase the memorable and deterrent aspects of a fence and that the use of energisers of sufficient capacity and an effective fence design are essential for an electric fence to be effective (Bertram et al. 2007). For custom-built electric fences they consider two plain wires (one energised) or four plain wires (two energised) as options. Four plain wire, with two wires energised, electric fences have been found to effectively control camel movement where internal fences have a lot of pressure, while where camels are familiar with electric wires and there is low pressure, a single electric wire is adequate (Bertram et al. 2007). For modification of an existing fence, Bertram et al. (2007) advise either an energised plain top wire or an energised wire offset on outriggers on the side from which camel pressure is expected, although they report that outriggers have not been proven effective for feral camels. As with the design of Dörges and Heucke (1995), while an electric fence is expected to be more effective than a standard cattle fence at controlling/managing camel movement, it is unlikely to be any stronger than a standard cattle fence at resisting damage from camels that attempt to penetrate or become entangled in the fence. Hence, the requirement for inspection and maintenance is likely to be as high as for standard cattle fencing.

The cable fence design reported by Bertram et al. (2007) used recycled heavy duty materials: 100 mm bore casings up to 4 m above ground and sunk 1.5 m into the ground, with 20 mm steel cable loosely strung 80 cm and 100 cm above the ground. Bertram et al. (2007) indicate that this design was developed and used by the joint management of UKTNP to control feral camel movement and successfully kept camels out of sensitive areas.

5.2 Cost and effectiveness

Costs associated with the different designs of fencing to prevent feral camels from accessing areas of high conservation or cultural value are variable depending upon the specific design of fencing used. Table 8.3 provides costing associated with a number of different designs for 'camel proof' fencing. The cost of fencing is very dependent on terrain and remoteness, and the figures in Table 8.3 are at best a guide to the potential cost. It should be clearly recognised that costs could be significantly higher for areas in difficult terrain or that are very remote.

Table 8.3: Cost per 100 metre and per kilometre for camel proof fencing.

Fence	Cost per 100 m $	Cost per km $
Cattle fence[1]	500 – 1000	1000 – 10 000
Electric fence[2]	1000	6000
Dörges & Heucke[3]	750 – 1500	1500 – 15 000
CAT camel fence[2]	3000 – 5000	30 000 – 50 000
Patjarr Spider (per spider)	500	

Note: standard[4] cattle fencing, for electric[5] fencing, for cattle fencing modified as per Dörges and Heucke (1995, 2003), for Centre for Appropriate Technology (CAT) camel proof, fence and for Patjarr Spider.

[1] PGC Fencing Contractors 2008, Alice Springs, pers. comm.

[2] Peter Barker 2007, Greening Australia, pers. comm.

[3] 150% cost of cattle fence

[4] 3-strand barbed wire

[5] 2-strand barbed and single-strand plain electric wire

Using Table 8.3 as a guide, the cost of protecting either a waterhole or specific area of conservation/cultural significance will vary considerably depending on the area to be fenced and the type of fence chosen to accomplish the task. Figure 8.4 provides a comparison of estimated costing for different size areas and fencing types.

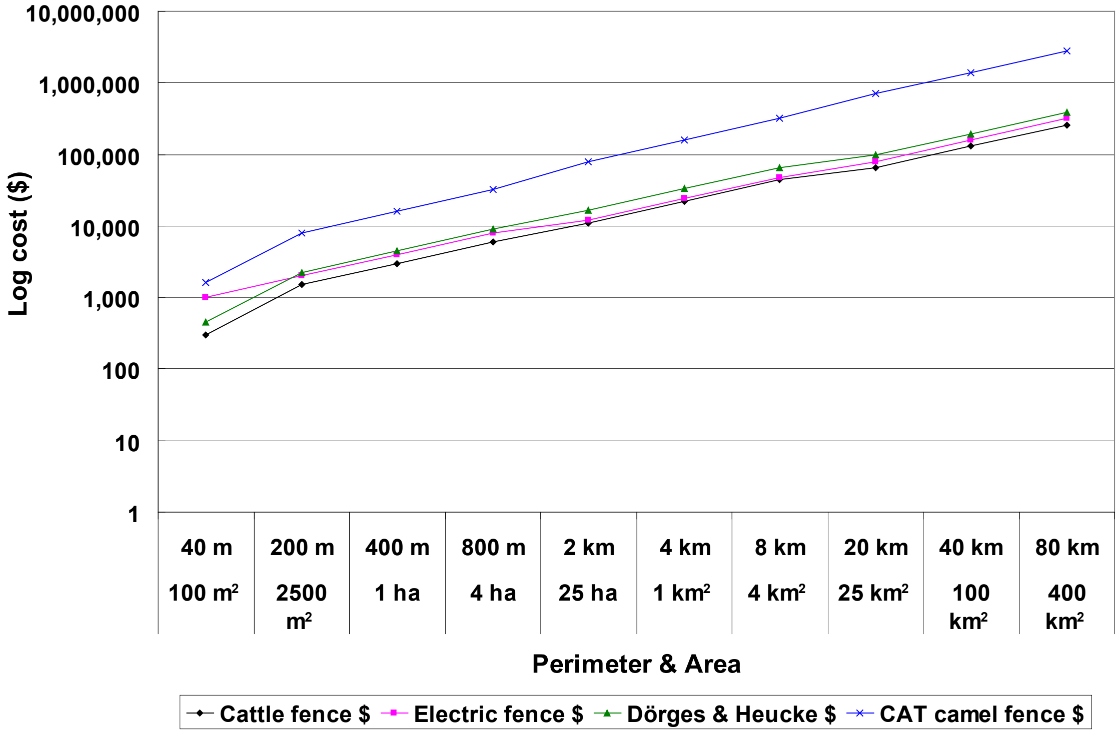

Figure 8.4: Cost of protecting different sized areas using different fence designs

Note: Costs are based on a square protection area and using the mid-point of each price range from Table 8.3 for fences less than 20 km length and first quarter of the price range for fences 20 km or more in length.

Figure 8.4 clearly demonstrates the dramatic increase in cost as area increases for each fence design. This makes it imperative that the specific outcome to be accomplished by fencing and the design required to achieve are unambiguously identified in the initial stages of developing any fencing proposal for the management of feral camels.

As indicated in Section 5.1, the effectiveness of the different designs in managing feral camel movement or preventing their access to specific sites/areas is very much dependent upon the design of fence. For the designs in Table 8.3, ranking from least to most effective is predicted to be the cattle fence, electric fence, Dörges and Heucke fence and finally the CAT camel fence. The Dörges and Heucke, design is ranked higher than the electric fence on the basis that for feral camels that have never encountered a fence, the visual component of the Dörges and Heucke design is likely to be more effective initially than the aversion effect of the electric fence, which is more effective as a learned response.

A number of theoretical fencing case studies have been modelled below to determine potential cost: total exclusion of camels from a waterhole, fencing of a small wetland to reduce camel impact, fencing of a community to exclude camels, boundary fencing of a pastoral property to restrict camel entry (one side and complete), and fencing the entire outer boundary of the pastoral area within the camel's distribution.

Waterhole

- Area of waterhole 13 m^2.
- Camels excluded from accessing waterhole out to 10 m from waterhole to limit camel degradation of surrounds and prevent silting of waterhole by camel generated erosion.
- Area of exclusion 460 m^2 (circular) or 576 m^2 (rectangular).
- Perimeter of exclusion 75 m (circular) or 96 m (rectangular).

- For total exclusion use CAT design fence.
- Fence cost $3000 (circular) or $3840 (rectangular).
- Ongoing maintenance should be minimal.

Wetland

- Area of wetland 25 ha.
- Camels restricted from accessing wetland and edge of wetland.
- Area of exclusion 25 ha (circular and rectangular).
- Perimeter of exclusion 1.77 km (circular) or 2 km (rectangular).
- For restricted access use Dörges & Heucke design fence (electric fence not considered suitable due to potential impact on native wildlife trying to access wetland; entire fence loses electrification and hence effectiveness if fence broken).
- Fence cost $14 602 (circular) or $16 500 (rectangular).
- Total exclusion fence (CAT design) would cost $70 800 (circular) or $80 000 (rectangular).
- Ongoing maintenance likely to be significant but would need to amount to 2–3 times the original fence cost before total cost would approach that of the total exclusion fence.

Community

- Area of community and airport for camel exclusion: 600 ha.
- Perimeter of community and airport for camel exclusion: 10.5 km.
- Immediate location of community and infrastructure reduces fence monitoring and maintenance as an issue.
- Restricted access electric fence design best to use for this purpose given potential effectiveness in keeping camels and other wildlife out of the community and airport.
- Fence cost $63 000.
- Require two access points through airport fence and four access points through community fence. Heavy duty cattle grids are suitable to prevent camels crossing access point.
- Six cattle grids cost $4000 each; total $24 000.
- Total fence cost $87 000.
- Equivalent total exclusion fence (CAT design) would cost $444 000.
- Ongoing maintenance likely to be significant but would need to amount to 4–5 times the original fence cost before total cost would approach that of the total exclusion fence. Expectation that fence monitoring and maintenance would be included in community general maintenance program.

Pastoral property

- Area of property 3 000 km^2.
- Perimeter of property 260 km (100 + 30 + 100 + 30 km sides).
- Lengths of fence are 100 km for a single side adjoining feral camel country and 260 km for entire property boundary.
- For restricted access on boundary use Dörges & Heucke design fence (electric fence considered less suitable due to entire fence or substantial length of fence losing electrification and hence effectiveness if fence broken).

- For single side 100 km length with one access point: fence cost $487 500, cattle grid cost $4000; total cost $491 500.
- For complete property boundary with four access points: fence cost $1 267 500, cattle grid cost $16 000; total cost $1 283 500.
- The above pricing is the cost to construct the fence from new. If existing fence is in place and is able to be modified, then cost will be considerably less, approximately one quarter the cost above, i.e. $121 875 for single 100 km boundary and $316 875 for entire boundary, assuming access points already in place.
- Monitoring and maintenance of the fence should be included with normal property fence maintenance.

Outer boundary of entire pastoral area abutting core camel distribution

- Length of boundary 11 000 km approximately.
- Cattle fence cost $35 750 000.
- Electric fence cost $66 000 000.
- Dörges & Heucke fence cost $53 625 000 for new fence and $13 406 250 to modify existing cattle fence, assuming entire boundary is already fenced.
- Total exclusion fence (CAT design): $330 000 000.

The theoretical case studies above give some idea of the potential costs associated with fencing specific small sites up to small communities and pastoral properties. As previously indicated, costs increase substantially as area increases and the actual effectiveness of any of the fence designs at either excluding or restricting camel access to the sites is poorly documented at best (Dörges & Heucke 1995, 2003, Barker & Elliat 2007, Bertram et al. 2007). Based on the available reports, the Centre for Appropriate Technology design is effective at excluding feral camels from sites but costs are extremely high compared with other fence designs, approaching an order of magnitude greater for very large areas.

5.3 Summary

Fencing to exclude or restrict feral camel access to particular sites or areas of conservation or cultural significance for Aboriginal people appears both feasible and economical provided that the area is not too large. Fencing costs range between $3000 to $16 500 for areas of 400 m^2 – 25 ha depending upon the fence design selected and the total area. For larger areas, fencing costs increase substantially and have to be weighed against the cost and effectiveness of alternative management methods.

It is important to stress that fencing does not have any impact on camel population numbers or population growth. There will be a requirement to actually reduce feral camel numbers in order to mitigate landscape level impacts across much of the camel's range. This can only be achieved with alternative control measures. Invariably, failure to control population growth will eventually result in population pressures on fencing that result in unacceptable levels of damage and maintenance costs.

6. Potential non-commercial control methods

6.1 Achilles Heel: Potential for the chemical, biological, or fertility control of feral camels

An extensive review of potential methods of chemical, fertility, and biological control for the camel in Australia was undertaken for this project by the Invasive Animals Cooperative Research Centre and is reported here (Lapidge et al. 2008). Additionally, the review provides suggestions for potential landscape delivery options for any new control methods.

The review provided a series of conclusions and recommendations for each of the considered options and these are given below. The review recommended ‘that the following techniques be investigated further, at least initially with camel stakeholder groups, animal welfare groups, the Australian Pesticide and Veterinary Medicine Authority, and the Australian public’.

- Low concentration delivery of nitrite or 1080 in raised water troughs. This may be made more specific if delivered at salt lakes where fresh water is more desirable for camels and species diversity is lower.
- Delivery of sodium or potassium nitrite via a camel specific feeding trough or raised salt lick at natural congregation points. Potassium chloride or 1080 may act synergistically with nitrite, which would lower the dose required and shorten the time to death.
- A combination of potassium chloride with a diuretic, with and without a nephrotoxic agent such as banamine and phenylbutazone, should be examined further as it may prove uniquely toxic to camels.
- Camelpox is worthy of further investigation, particularly in reference to its spread in more natural nomadic camel populations within the species range and the humaneness of the virus. Regardless, camelpox is unlikely to be the ‘calicivirus’ of camels in Australia, and would be principally introduced to limit population recruiment.
- An immunocontraceptive vaccine technology that is orally active and has a species-specific immunogen is favoured for fertility control. Research into a feral pig anti-fertility vaccine that can be used as a platform from which to undertake similar research in camelids holds the greatest hope for this in the immediate future but requires funding for extension of the work into camels.
- Three other novel approaches to manipulating fertility warrant attention: phage panned peptide technology, the Talwar protein, and antigen delivery systems such as bacterial ghosts” (Lapidge et al. 2008).

Lapidge et al. (2008) further recommended that a balanced research and development approach be taken rather than focusing on a single management tool, and that any future research program should have short-, medium-, and long-term products to provide incremental improvements in managing the camel population in Australia. Finally, they identified that any research must be publically acceptable and humane (Lapidge et al. 2008).

7. Recommendations

- That aerial shooting from helicopters is recognised as the optimal control action to achieve large population density reductions over broadscale areas, particularly in short time frames, and the only available control action that can be used in very remote or inaccessible areas.
- That aerial shooting from helicopters be based on specific targets and outcomes and that to achieve this objective, removed and final population densities must be known, requiring pre- and post-control population monitoring.
- That any proposed camel management program, particularly involving aerial shooting, must be fully funded and adequately resourced to meet the proposed outcomes, including all monitoring requirements.
- That it is recognised that effective management of camels and their impacts will involve the integration of all available control methods, both non-commercial and commercial, and that the development of scale-dependent, multiple outcome management plans integrated into the national framework will be key to the effective management of feral camel impacts in Australia.
- That it is recognised that ground-based shooting has limited applicabilty for broadscale population reduction and will primarily fill a long-term management role of maintenance of low density populations through opportunistic shooting integrated with other activities.

- That it is recognised that exclusion fencing is not a broadscale level management tool. Fencing is likely to be most effective when applied at the local scale to protect high value assets.
- That the following techniques are investigated further for the chemical, biological and fertility control of camels:
    - Low concentration delivery of nitrite or 1080 in raised water troughs. This may be made more specific if delivered at salt lakes where fresh water is more desirable for camels and species diversity is lower.
    - Delivery of sodium or potassium nitrite via a camel-specific feeding trough or raised salt lick at natural congregation points. Potassium chloride or 1080 may act synergistically with nitrite, which would lower the dose required and shorten the time to death.
    - A combination of potassium chloride with a diuretic, with and without a nephrotoxic agent such as banamine and phenylbutazone, should be examined further as it may prove uniquely toxic to camels.
    - Camelpox is worthy of further investigation, particularly in reference to its spread in more natural nomadic camel populations within the species range and the humaneness of the virus. Regardless, camelpox is unlikely to be the 'calicivirus' of camels in Australia, and would be principally introduced to limit population recruiment.
    - An immunocontraceptive vaccine technology that is orally active and has a species-specific immunogen is favoured for fertility control. Research into a feral pig anti-fertility vaccine that can be used as a platform from which to undertake similar research in camelids holds the greatest hope for this in the immediate future but requires funding for extension of the work into camels.
    - Three other novel approaches to manipulating fertility warrant attention: phage panned peptide technology, the Talwar protein, and antigen delivery systems such as bacterial ghosts (Lapidge et al. 2008).

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9. Appendices

Appendix 8.1: Draft Standard Operating Procedure for the Aerial Shooting of Feral Camels

Adapted from the *Standard Operating Procedure for the Aerial Shooting of Feral Horses* (Sharp & Saunders 2004)

Application

- Shooting should only be used in a strategic manner as part of a coordinated program designed to achieve sustained effective control.
- Aerial shooting is a cost-effective method where camel density is high. Costs increase greatly as camel numbers decrease.
- Aerial shooting is used to control feral camels in remote, inaccessible, or rugged terrain where camels cannot be caught, when there is no viable market for them, or when a rapid reduction in density is required.
- In areas of heavy cover (e.g. vegetated creek lines and closed woodlands), effectiveness is limited since camels may be concealed and difficult to locate from the air.
- The optimal period for aerial shooting is during dry seasons or droughts when many groups of camels are forced to congregate around remaining areas of water and feed. Shooting during drought reduces the number of camels that would otherwise die slowly of hunger or thirst.
- For safety reasons, shooting from a helicopter cannot be undertaken in adverse weather conditions (e.g. strong wind, rain, low cloud).
- Shooting of feral camels should only be performed by competent, trained personnel who have been tested and accredited for suitability to the task and marksmanship and who hold the appropriate licences [e.g. in NSW shooters must complete the Feral Animal Aerial Shooter Training (FAAST) course].
- Helicopter pilots must hold the appropriate licences and permits and be skilled and experienced in aerial shooting operations.
- Helicopter operators must have approval from the Civil Aviation Safety Authority to undertake aerial shooting operations.
- Aerial shooting should comply with all relevant Federal and State/Territory legislation, policy, and guidelines.
- Storage, use, and transportation of firearms and ammunition must comply with relevant legislative requirements.

Animal welfare considerations

Impact on target animals

- Humaneness of aerial shooting depends on the skill and judgement of both the shooter and the pilot. If properly carried out, it can be a humane method of killing feral camels. On the other hand, if inexpertly carried out, shooting can result in wounding which may cause considerable pain and suffering.
- Aerial shooting should not be carried out if the nature of the terrain reduces accuracy, resulting in too many wounding shots, and prevents the humane and prompt dispatch of wounded animals.
- Shooting must be conducted in a manner which maximises its effect, thus causing rapid death. This requires the use of appropriate firearms and ammunition.
- Only head (brain) or chest (heart-lung) shots must be used. Shooting at other parts of the body is unacceptable.

- With aerial shooting, chest shots are preferred over head shots. The heart and lungs are the largest vital area and an accurate shot is more achievable, particularly within the range of unusual angles encountered when shooting from above. Wounding in the chest/shoulder area, if not lethal, is likely to severely restrict an animal's ability to move and will facilitate the placement of follow-up lethal shots. However, compared with an accurate head shot, a chest shot does not render the animal instantaneously insensible. Although shots to the head are more likely to cause instantaneous loss of consciousness, there is a high risk of missing a smaller, moving target area.
- Death from a shot to the chest is due to massive tissue damage and haemorrhage from major blood vessels. Insensibility will occur after an interval ranging from a few seconds to a minute or more. If a shot stops the heart functioning, the animal will lose consciousness very rapidly. Correctly placed head shots cause brain function to cease and insensibility is immediate.
- The shooter must be certain that each animal is dead before another is targeted. Wounded camels must be located and killed as quickly and humanely as possible with further shot(s) directed at the chest or head. If left, wounded animals can suffer from the disabling effects of the injury, from sickness due to infection of the wound, and from pain created by the wound.
- Helicopter shooting operations do not always result in a clean kill for all animals; therefore prompt follow-up procedures are essential to ensure that all wounded animals are killed. This can be achieved by:
    - Flying the helicopter back to wounded animals so that further shot(s) can be placed into the vital areas of the animal.
    - Using a deliberate policy of 'overkill' whereby numerous rounds are used per animal instead of a single shot. Since it is very difficult to assess if an animal is dead from a distance it is essential that after the initial shot, another one or more shots be fired into the chest or head to ensure a quick death.
    - Using a ground crew of several individuals walking or on all-terrain vehicles to locate and humanely kill any wounded animals in areas that are accessible.

  The cost of ammunition and extra flying time must not deter shooters from applying the appropriate follow-up procedures.
- To minimise the animal welfare implications of leaving dependent calves to die a slow death from starvation it is preferable not to undertake aerial shooting programs when cows have dependent young at foot. Calving is concentrated over winter and spring. Apart from the welfare implications, control at times of calving may be less effective as females are usually more cryptic and tend to leave the group to give birth in isolated and/or sheltered locations.
- If lactating cows are shot, efforts should be made to find dependent calves and kill them quickly and humanely.

Impact on non-target animals

- Shooting is relatively target specific and does not usually impact on other species. However, there is always a risk of injuring or killing non-target animals, including livestock, if shots are taken before an animal has been positively identified.

Health and safety considerations

- The potentially hazardous nature of aerial shooting requires that safety protocols be strictly followed. Each team member must be aware of and trained in all aspects of helicopter and firearm safety.
- Shooting from a helicopter can be hazardous, particularly in areas of rugged topography. The combination of low-level flight, close proximity to obstacles (trees, rocks, wires) and the use of firearms make this task extremely hazardous.

- It is essential that ejected firearm shells do not interfere with the safe operations of the helicopter. It may be necessary to fit a deflector plate to the firearm to ensure shells are ejected safely.
- Firearm users must strictly observe all relevant safety guidelines relating to firearm ownership, possession, and use.
- When not in use, firearms must be securely stored in a compartment that meets state legal requirements. Ammunition must be stored in a locked container separate from firearms.
- Adequate hearing protection should be worn by the shooter and others in the immediate vicinity of the shooter. Repeated exposure to firearm noise can cause irreversible hearing damage.
- Safety glasses are recommended to protect the eyes from gases, metal fragments, and other particles.

Equipment required

Firearms and ammunition

- Self-loading rifles (SLR) with large magazine capacity such as the M14, M1A, L1A1, or Heckler and Koch M19 in .308 calibre are suitable. They should be fitted with a spot on/aim-point/red dot scope. Soft- or hollow-point ammunition with heavy projectiles no smaller than 150 grain should be used.
- Shotguns are NOT recommended for use on feral camels. If they must be used in an emergency situation, rifled slugs are to be used as ammunition.
- To provide a backup in case of firearm/ammunition malfunction, at least two weapons should be carried by shooters at all times.
- The accuracy and precision of firearms should be tested against inanimate targets prior to the commencement of any shooting operation.

Aircraft

- Turbine-powered helicopters are preferred (e.g. Bell Jetrangers, Hughes 500, Kawasaki, etc.)
- It is recommended that GPS (global positioning systems) and computer mapping equipment such as GIS (geographic information systems) are used to assist in the accurate recording of information (e.g. where animals are shot) and to eliminate the risk of shooting in off-target areas.

Other equipment:

- Flight helmet (with intercom)
- Fire-resistant flight suit
- Safety harness
- Other personal protective equipment including lace-up boots, gloves, and appropriate eye and hearing protection
- Survival kit (including a first-aid kit)
- Emergency locating beacon
- Lockable firearm box
- Lockable ammunition box.

Procedures

- Target camels should be mustered away from watercourses before being shot, as wounded animals will be difficult to locate if they go down in water.
- Once a target is sighted and has been positively identified, the pilot should position the helicopter as close as is safe to the target animal to permit the shooter the best opportunity for a humane kill.
- The pilot should aim to provide a shooting platform that is as stable as possible. Shooting from a moving platform can significantly detract from the shooter's accuracy.

- A feral camel should only be shot at when:
  - it can be clearly seen and recognised
  - it is within the effective range of the firearm and ammunition being used and
  - a humane kill is probable. If in doubt, do NOT shoot.
- Camels nearly always trot in single file and their head does not move a great deal as they travel. In a line of running animals, always shoot the animals at the tail end first and then move forward until all animals in the line have been shot.
- In most aerial shooting situations the shooter should aim at the chest, to destroy the heart, lungs and major blood vessels. The following aiming point is recommended:

  <u>Chest shot</u> (this is the preferred point of aim for aerial shooting)

  Side view

  - The firearm is aimed at the centre of a line encircling the minimum girth of the animal's chest, immediately behind the forelegs.
  - The shot should be taken slightly to the rear of the shoulder blade (scapula). This angle is taken because the scapula and humerus provide partial protection of the heart from a direct side-on shot.
- Shots to the head should only be attempted at short ranges and in ideal conditions. The brain is a relatively small target that is well protected by bone. Only the slightest misplacement of the bullet can result in non-lethal and debilitating wounds, such as a broken jaw. Aiming points for head shots are as follows:

  <u>Head shots</u>

  Temporal position (side view)

  - This shot is occasionally used where a second shot needs to be delivered to an injured animal that is lying on its side.
  - The camel is shot from the side so that the bullet enters the skull midway between the eye and the base of the ear. The bullet should be directed horizontally.

  Frontal position (front view)

  - This position is occasionally used when an animal faces the shooter.
  - The firearm should be directed at the point of intersection of diagonal lines taken from the base of each ear to the opposite eye aiming at the spine.
- If an animal is wounded by an initial shot but not killed, a 'fly back' procedure should be adhered to immediately where the wounded animal is located and additional shot(s) are administered to ensure a quick death. Any wounded animal in a group should be killed immediately before any further animals are targeted and shot.
- After a group of animals has been shot, it is essential that the pilot fly back over it to search for animals that still may be alive.
- When shooting feral camels, all animals should receive multiple shots to the vital areas to ensure a rapid death. Animals may appear to be dead but may only be temporarily unconscious.
- Records should be kept of numbers and locations of animals killed, hours flown, ammunition used, and details of fly-back procedures.

Appendix 8.2: Draft Standard Operating Procedure for the Ground Shooting of Feral Camels

Adapted from the *Standard Operating Procedure for the Ground Shooting of Feral Horses* (Sharp & Saunders 2004)

Application

- Shooting should only be used in a strategic manner as part of a coordinated program designed to achieve sustained effective control.
- Ground shooting is time consuming and labour intensive, and is therefore not considered an effective method for large-scale control.
- Ground shooting as a means of population control is not suitable in inaccessible, wooded, or rough terrain where sighting of target animals and accurate shooting is difficult or when wounded animals cannot easily be followed up and killed.
- The optimal period for ground shooting is during dry seasons or droughts when many groups of camels are forced to congregate around areas with water and feed. Shooting during drought reduces the number of camels that would otherwise die slowly of hunger or thirst.
- Sporadic shooting from the ground may teach camels to avoid certain areas, making overall control difficult.
- Shooting of feral camels should only be performed by skilled operators who have the necessary experience with firearms and who hold the appropriate licences and accreditation.
- Storage and transportation of firearms and ammunition must comply with relevant legislative requirements.

Animal welfare considerations

Impact on target animals

- The humaneness of shooting as a control technique depends almost entirely on the skill and judgment of the shooter. If properly carried out, it can be a humane method of destroying feral camels. On the other hand, if inexpertly carried out, shooting can result in wounding which may cause considerable pain and suffering.
- Shooting must be conducted with the appropriate firearms and ammunition and in a manner which aims to cause immediate insensibility and painless death.
- Shooters should not shoot at an animal unless it is clearly visible and they are confident of killing it with a single shot.
- Only head (brain) or chest (heart-lung) shots must be used. Shots to the head are preferred over chest shots as they are more likely to cause instantaneous loss of consciousness. Chest shots do not render animals instantaneously insensible and are likely to result in a higher incidence of wounding. Shooting at other parts of the body is unacceptable.
- Group flight response is a limiting factor for humane and instantaneous killing of camels.
- If possible, all camels in a group should be killed before any further groups are targeted.
- Wounded camels must be located and killed as quickly and humanely as possible with a second shot, preferably directed to the head. If left, wounded animals can escape and suffer from pain and the disabling effects of the injury.
- Culling programs should be timed to minimise the risk of orphaning dependent calves or causing abortion when females are in late pregnancy.

- If lactating females are inadvertently shot, efforts should be made to find dependent young and kill them quickly and humanely with a shot to the brain.

Impact on non-target animals

- Shooting is relatively target specific and does not usually impact on other species. However, there is always a risk of injuring or killing non-target animals, including livestock, if shots are taken only at movement, colour, shape, or sound. Only shoot at the target animal once it has been positively identified and never shoot over the top of hills or ridges.

Health and safety considerations

- All participants in the culling program should stand well behind the shooter when an animal is being shot. The line of fire must be chosen to prevent accidents or injury from stray bullets or ricochets.
- Firearm users must strictly observe all relevant safety guidelines relating to firearm ownership, possession, and use.
- Firearms must be securely stored in a compartment that meets state legal requirements. Ammunition must be stored in a locked container separate from firearms.
- Adequate hearing protection should be worn by the shooter and others in the immediate vicinity of the shooter. Repeated exposure to firearm noise can cause irreversible hearing damage.
- Safety glasses are recommended to protect the eyes from gases, metal fragments, and other particles.
- Care must be taken when handling feral camel carcasses as they may carry diseases such as meliodosis, ringworm, and dermatophilosis that can affect humans and other animals. Routinely wash hands and other skin surfaces after handling carcasses. Carcasses can be heavy, so care must be taken when lifting/dragging.

Equipment required

Firearms and ammunition

- Large calibre, high powered, centre-fire, bolt action or semi-automatic rifles (at least equal to .308 performance), fitted with a telescopic sight should be used. Hollow-point or soft-nosed ammunition, minimum 165 grain, should be used.
- Shotguns are NOT recommended for use on feral camels. If they must be used in an emergency situation, rifled slugs are to be used as ammunition.
- The accuracy and precision of firearms should be tested against inanimate targets prior to the commencement of any shooting operation.

Other equipment:

- lockable firearm box
- lockable ammunition box
- personal protective equipment (hearing and eye protection)
- first-aid kit.
- Appropriate maps identifying access trails and land tenure.

Procedures

- Camels must NOT be shot from a moving vehicle or other moving platform as this can significantly detract from the shooter's accuracy.
- The shooter must be in a firm, safe and stable position before taking a shot.

- The objective is to fire at the closest range practicable in order to reduce the risk of non-lethal wounding. Accuracy with a single shot is important to achieve an immediate and, therefore, humane death.
- A camel should only be shot at when:
  - It is stationary and can be clearly seen and recognised
  - It is within the effective range of the firearm and ammunition being used
  - A humane kill is probable. If in doubt, do NOT shoot.
- Ensure there are no other camels behind the target animal that may be wounded by the shot passing through the target.
- Although camels are large animals, the vital areas targeted for clean killing are small. Shooters should be adequately skilled that is, be able to consistently shoot a group of not less than 3 shots within a 10 cm target at 100 metres. Shooters should also be able to accurately judge distance, wind direction and speed, and have thorough knowledge of the firearm and ammunition being used.
- The shooter must aim either at the head, to destroy the major centres at the back of the brain near the spinal cord, or at the chest, to destroy the heart, lungs, and great blood vessels. This can be achieved by one of the following methods:

  <u>Head shots</u>

  Frontal position (front view)

  - The firearm should be directed at the point of intersection of diagonal lines taken from the base of each ear to the opposite eye. The bullet should be directed horizontally.

  Temporal position (side view)

  - The camel is shot from the side so that the bullet enters the skull midway between the eye and the base of the ear. The bullet should be directed horizontally.

  <u>Chest Shots</u>

  Side view

  - The firearm is aimed horizontally at the centre of a line encircling the minimum girth of the animal's chest, immediately behind the forelegs. The shot should be taken slightly behind and below the shoulder at the point immediately behind the elbow.
- Shooting of individuals should stop when the flight response of the herd limits further accurate shooting.
- Bulls should be shot first. This tends to confuse the remaining camels, slows their retreat and increases the chances of culling them.
- The target animals in a group should be checked to ensure they are dead before moving on to the next group of animals. *Always approach the animal from the dorsal (or spinal) side to prevent injury from kicking legs.* Death of shot animals can be confirmed by observing the following:
  - Absence of rhythmic, respiratory movements
  - Absence of eye protection reflex (corneal reflex) or 'blink'
  - A fixed, glazed expression in the eyes
  - Loss of colour in mucous membranes (become mottled and pale without refill after pressure is applied).
- If death cannot be verified, a second shot to the head should be taken immediately.